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DEPARTMENT OF THE HISTORY OF ARTS

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CHICAGO, ILLINOIS

1954

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ENCYCLOPÆDIA BRITANNICA.

THEORETICAL ASTRONOMY.

OF THE MOON.

Theoretical
Astronomy.

WHEN we reflect on the immense addition that has been made to our knowledge of the constitution of the universe by means of the telescope, we may reasonably indulge an expectation that the further advances yet to be made will be closely connected with the extension of the power of that invaluable instrument.

Besides the power which the telescope gives of penetrating into remote space, it enables us to discover the nature and constitution of the bodies which are nearer to us. The admirable discoveries of Newton, as will be explained in the sequel, have taught us that the planets are not all composed of matter of the same density. But besides the property of weight, which belongs to all matter whatever, it has others which are peculiar to certain bodies, such as solidity, fluidity, &c. The Newtonian law of gravity reveals nothing of these; and it is only by the aid of the telescope that we can ever hope to acquire the slightest knowledge of the constitution of the planetary matter.

The structure of the more remote planets is probably beyond our knowledge, even when aided by the most improved telescopes; but it seems not unreasonable to indulge a hope of going some way in ascertaining the nature of the bodies nearer to us. Jupiter's belts have with great probability been supposed to be masses of clouds in the region of his equator; and Herschel discovered, to the great delight of astronomers, that the polar regions of Mars assumed a whiteness of appearance when obliquely exposed to the light of the sun, just as if, like those of the earth, they were covered with snow. Above all, the moon presents to the astronomer an extensive field, not barely for conjecture, but for instructive observation. The solar spots have given occasion to much ingenious speculation; but the distance of the moon is only one four hundredth part of the distance of the sun from the earth, and in the same proportion our power of becoming acquainted with the constitution of the latter exceeds that of ever knowing intimately the constitution of the former. It is no wonder, then, that the attention of astronomers in all ages has been directed to the companion of our earth, whose structure may with great probability be supposed to resemble considerably the body round which it revolves, and of which it is not improbable that it may have once been a part.

VOL. IV.

CONTINUATION OF CHAP. III.

SECT. IV.—Of the Rotation and Libration of the Moon.

The surface of the moon is diversified by dark patches, the number of which appears prodigiously increased in the telescope. These patches or dark spots present no changes of form like those of the sun, but permanently exhibit the same uniform appearances, and retain their relative situations with regard to each other, and also, with some slight variations, to the apparent centre of the moon. The moon, therefore, at all times presents very nearly the same face to the earth. But if this were rigorously the case, it would follow that the moon revolves about an axis, perpendicular to the plane of her orbit, in the same time in which she completes a sidereal revolution about the earth, and that the angular velocities of the two motions are exactly equal. It is, however, proved by observation, that there are some variations in the apparent position of the spots on the lunar disk. Those which are situated very near the border of the disk alternately disappear and become visible, making stated periodical oscillations. But as they suffer no sensible changes in their respective positions, and always re-appear under the same form and magnitude when they return to the same position, it is inferred that they are permanently fixed to the surface of the moon; and their oscillations consequently seem to indicate a sort of vibratory motion of the lunar globe, which is known by the appellation of its *libration*. This motion has, however, no real existence. The phenomenon is the complicated result of several optical illusions, and does not depend in any degree on the rotation of the moon, which, relatively to us, is perfectly equable; or at least, if it be subject to irregularities, they are too minute to be appreciated.

In order to form a precise idea of the phenomenon of the libration, we must consider that the disk of the moon, seen from the centre of the earth, is terminated by the circumference of a great circle of the moon, the plane of which is perpendicular to a line drawn from the earth's centre to that of the moon. The lunar hemisphere is projected on the plane of this circle turned towards the earth; and if the moon did not revolve round her axis, the projection would incessantly present different appearances to us, inas-

A

Theoretical Astronomy. much as the radius vector drawn from the centre of the earth by which the plane of projection is determined, would intersect the surface of the moon in a different point, at every new position in her orbit. But in consequence of her rotation, the radius vector is always directed to nearly the same point of the lunar surface, and would be always directed exactly to the same point if the angular velocity of rotation corresponded exactly with the angular velocity in the orbit. But the rotation of the moon is sensibly uniform; while the motion of revolution, being affected by the periodic inequalities, is sometimes slower and sometimes more rapid. The apparent rotation occasioned by the revolution of the moon round the earth is consequently in such cases not exactly counterbalanced by the real rotation, which remains constantly the same. Hence the different points of the lunar globe must appear to turn about her centre, sometimes in one direction, and sometimes in the contrary, and the same appearances be produced as would result from a small oscillation of the moon, in the plane of her orbit, about the radius vector drawn from her centre to the earth. The spots near the eastern or western edge of her disk disappear according as her motion in her orbit is more or less rapid than her mean motion. This is called the *Libration in Longitude*.

Further; the axis of rotation of the moon is not exactly perpendicular to the plane of her orbit. If we suppose the position of this axis fixed, during a revolution of the moon it inclines more or less to the radius vector, so that the angle formed by these two lines is acute during one part of her revolution, and obtuse during another part of it; hence the two poles of rotation and those parts of her surface which are near these poles are alternately visible from the earth. This is the *Libration in Latitude*.

Besides all this, the observer is not placed at the centre of the earth, but at its surface. It is the radius drawn from his eye to the centre of the moon which determines the middle point of her visible hemisphere. But, in consequence of the lunar parallax, it is obvious that this radius must cut the surface of the moon in points sensibly different according to the height of that luminary above the horizon. An observer at the surface of the earth perceives points on the upper part of the moon's disk, at the time of her rising, which could not be seen from the centre. In proportion as the moon acquires a greater elevation, these points approach the border of the disk, and finally disappear, while new ones become visible on the eastern part of the disk, which increase in number as the moon descends towards the horizon; so that in the course of a day she appears to oscillate about her radius vector in the direction of the earth's rotation. This phenomenon constitutes what is called the *Diurnal Libration*, and is evidently the effect of the lunar parallax.

The libration in latitude and the diurnal libration were discovered by Galileo soon after the invention of the telescope. It was Hevelius who discovered the libration in longitude, and explained it by the equable rotatory motion of the moon combined with her unequal velocity in her orbit.

To the inhabitants of the moon, if such there be, the earth will appear as a species of moon, much larger than the moon appears to us, but visible only to that hemisphere which is turned towards the earth. At those places which are situated near the border of her visible disk, the earth will sometimes rise a few degrees above the horizon; and an inhabitant of the moon placed near the middle of the hemisphere presented to the earth will always see the earth near his zenith, making oscillations of only a few degrees in consequence of the libration. But an inhabitant of the other hemisphere will never see

Theoretical Astronomy. the earth at all; so that while one hemisphere of the moon is constantly enlightened, during her long night, by the light reflected from the earth, the other remains in constant darkness. In regard, therefore, to the distribution of light, one of the lunar hemispheres enjoys very great advantages over the other.

The elements of the rotation of the moon, that is to say, the position of her equator, the place of its nodes, and its inclination to the plane of the ecliptic, are found by the same methods which have been explained for determining the corresponding elements relatively to the sun. The geocentric positions of the spots are observed in the same manner; and in converting them into selenocentric latitudes and longitudes, the same formulæ may be employed, with a slight modification rendered necessary by the inclination of the lunar orbit to the ecliptic. One circumstance, not less remarkable than the coincidence which obtains between the times of rotation and sidereal revolution, is, that the nodes of the lunar equator coincide with those of the moon's orbit, if not exactly, at least so nearly, that the differences are so small as to fall within the probable errors of observation and calculation. All the observations since the time of Hevelius agree in showing that the longitude of the descending node of the equator is very nearly equal to the mean longitude of the ascending node of the orbit; whence it follows that the nodes of the equator have a retrograde motion equal to that of the nodes of the orbit. With regard to the inclination of the lunar equator to the ecliptic, Mayer states it to be $1^{\circ} 29'$, and Lalande $1^{\circ} 43'$. According to the latest computations made from the observations of Bouvard, the mean inclination of the lunar equator to the ecliptic is $1^{\circ} 28' 42''$. Mr Baily makes it $1^{\circ} 30' 10'' \cdot 8$. Since the descending node of the equator coincides with the ascending node of the orbit, it is evident that its plane must be situated between the planes of the ecliptic and orbit, making an angle of about $1^{\circ} 30'$ with the first, and of $3^{\circ} 39'$ with the second.

Suppose three planes to pass through the centre of the moon, one of which represents her equator, the second the mean plane of her orbit, and the third parallel to the ecliptic. It is evident, from what precedes, that these three planes have a common section; that the first falls between the other two, making with them respectively the angles $3^{\circ} 39'$ and $1^{\circ} 30'$. In the space of 6793 days, the time of a revolution of the nodes of the lunar orbit, the poles of the first two planes describe about the pole of the ecliptic, in a direction contrary to the order of the signs, two small circles parallel to the ecliptic, and of which the semidiameters are respectively the arcs $1^{\circ} 30'$ and $5^{\circ} 9'$. Hence the difference between the longitudes of these two poles is constantly 180° , and the three poles are situated on the same great circle, that of the ecliptic being between the two others.

These results, which rank among the most curious discoveries of modern astronomy, were first obtained by Dominic Cassini: they were shown by Lagrange to be necessary consequences of the attraction which the earth exercises on the lunar spheroid.

The positions of the spots on the moon's surface are determined by their distance from the lunar equator, and from a conventional meridian, that is, by their selenocentric latitudes and longitudes, after the manner in which the position of places is determined on the surface of the earth. The first meridian is assumed to be that which passes through the pole of the visible hemisphere when the true place of the moon in her orbit is equal to her mean place; hence the first meridian is always very near the middle of the face which the moon turns towards the earth, never deviating from it farther than by a quantity

Theoretical
Astronomy.

Theoretical
Astronomy.

equal to the equation of the moon, or her libration in longitude. The rotatory motion being equal to that of revolution, the selenocentric longitude of the first meridian, at any epoch, is found by adding 180° to the mean longitude of the moon; and this gives also the distance of the first meridian from the ascending node of the lunar equator. The position of the equator and first meridian being determined, the co-ordinates of a spot are computed without difficulty; and in this manner catalogues of the spots have been formed, and arranged according to their latitudes and longitudes.

SECT. V.—*Of the Nature and Constitution of the Lunar Substance.*

It has already been observed, that a slight attention to the different phases of the moon is sufficient to prove that she is an opaque spherical body, shining only by virtue of the light which she receives from the sun. The line bounding the visible part of her surface has exactly the form which would be produced by an illuminated hemisphere brought into different positions with respect to the eye; and the circular contour of the obscured portion of the sun during a solar eclipse could only be caused by the interposition of a spherical body. Besides, the parts of her hemisphere turned towards the earth, which the sun's rays do not reach, are in some circumstances sufficiently discernible, and she has then the same circular appearance which she exhibits when at the full.

But if the light which comes to us from the moon is only that which she receives from the sun and reflects back to the earth, how does it happen, it may be asked, that the portion of her disk not directly exposed to the solar rays is distinctly visible for some days after the new moon? This phenomenon was ascribed by the ancients to the native light of the moon, to which, on account of its pale ashy hue, they gave the name of *lumen incinerosum*. The explanation which is now generally given was first suggested by a celebrated painter, Leonard da Vinci. It consists in supposing that a portion of the light which is reflected from the illuminated hemisphere of the earth to the moon undergoes a second reflection at the lunar surface, and is transmitted back to the earth. The ancients were confirmed in their opinion respecting the native light of the moon, by observing that she is not altogether invisible in her eclipses. Plutarch, indeed, ingeniously ascribes her appearance under these circumstances to the light of the stars reflected from the moon; a cause, however, totally inadequate to produce the effect. This phenomenon is now generally ascribed to the scattered beams of the sun bent into the earth's shadow by the refraction of its atmosphere.

The opinion that the moon's light is chiefly, if not wholly, caused by the reflection of the sun's rays at the lunar surface, has prevailed in all ages; and indeed no other explanation seems to have been thought of till it was suggested by Licetus, professor of philosophy at Bologna, as being more probable that the moon possesses a phosphorescent quality, and that the sun's influence is only wanted to occasion the propulsion of the light which lies absorbed in her substance. This idea has been adopted by Professor Leslie, whose arguments in its support are at least extremely plausible and ingenious. So far as the appearances, and the explanation of the phases, are concerned, it is evidently matter of indifference whether we suppose that the solar rays are reflected from the surface of the moon, or that they exert an action in virtue of which the moon emits rays of her own. In either case it is that part of her surface only which is exposed to the

impact of the solar rays that sends forth light to the earth.

The principal argument in favour of the phosphorescent nature of the moon is founded on the quantity of light which proceeds from her surface. It is evident that the moon does not act as a polished speculum, and reflect the whole of the incident rays; for in that case, as is known from the laws of *Catoptrics*, she would merely reflect an image of the sun, equally bright, varying in size according to her different positions relatively to the sun and the earth, and increasing till she arrives at her opposition, when her diameter would appear equal to about the 458th part of its real dimensions. Her phases could never be distinguished, and she would only appear to approach to or recede from the earth, in proportion as her diameter increased or diminished. It follows, therefore, that the moon's surface must be irregular, or what is termed a *mat surface*, that is, of such a nature, that from every point of it the rays of light are reflected in all directions indifferently. According to the experiments of Bouguer, a white surface of this sort, for instance paper, or plaster of Paris, reflects only about the 150th part of the rays which fall upon it in a perpendicular direction; and the proportion is less as the angle of incidence becomes more oblique. Making allowance for the irregular surface and obscure spots of the moon, Mr Leslie computes that the solar light which she remits to the earth must be attenuated at least 105 million times; but Bouguer's experiments show that the moon's light is between the 250,000th and 300,000th part of the direct light of the sun, or about 350 times greater than the computed amount of reflected light. If every part of the moon's surface reflected the light in the most perfect manner, it may be shown that only the 210,000th part of the rays which she receives from the sun would be thrown off in the direction of the earth; a quantity not much exceeding that which, according to Bouguer's estimate, we actually receive from her. Mr Leslie states that he found the intensity of the moon's light to approach the 150,000th part of the direct light of the sun; a result which, if admitted, must be entirely decisive of the question; for as the utmost possible quantity of reflected light cannot exceed the 210,000th part, it follows that the excess must be owing to the spontaneous light of the moon. Hence this ingenious philosopher concludes that the body of the moon is a phosphorescent substance, like the *Bolognian Stone*, which possesses the property of shining for some time when carried into a dark room, after having been exposed to the light of the sun. A fact first observed by the celebrated Arago seems to increase the probability of this opinion. All rays reflected from a surface not metallic acquire a peculiar modification, or become *polarized*; but as the rays of the moon are not so modified, it is inferred that they have not undergone a reflection at her surface.

The secondary light of the moon, of which we have already made mention, affords arguments in favour of her native light precisely similar to the above. If the earth reflected, like a mirror, the whole of the incident rays, the illumination produced by the reflection would amount to about a 16,000th part of that which is caused by the sun; but as the sea reflects only about a 55th part of those rays, and the land a still smaller proportion, we may suppose that the reflected light of the earth does not exceed a millionth part of the direct light of the sun. It is extremely doubtful whether a light so greatly attenuated would suffice to render the moon visible. The lucid bow, or silvery thread of light, which, proceeding from the extremities of the lunar crescent, seems to embrace her unenlightened orb, is easily explicable on this hypothesis;

Theoretical Astronomy. whereas it can hardly be satisfactorily accounted for by ascribing it to the secondary illumination from the earth.

"I should rather refer it," says Mr Leslie, "to the spontaneous light which the moon may continue to emit for some time after the phosphorescent substance has been excited by the action of the solar beams. The lunar disk is visible although completely covered by the shadow of the earth: nor can this fact be explained by the inflection of the sun's rays in passing through our atmosphere; for why does the rim appear so brilliant? Any such inflection could only produce a diffuse light, obscurely tinging the boundaries of the lunar orb; and, in this case, the earth, presenting its dark side to the moon, would have no power to heighten the effect by reflection. But even when this reflection is greatest about the time of conjunction, its influence seems extremely feeble. The lucid bounding arc is occasioned by the narrow *lunula*, which, having recently felt the solar impression, still continues to shine; and from its extreme obliquity, glows with concentrated effect." (*Inquiry into the Nature and Propagation of Heat.*)

Although these arguments go far to support the ancient opinion of the native light of the moon, they are not entirely conclusive; and indeed cannot be easily reconciled with some of the phenomena. If the moon shines in virtue of her native light, rays will be emitted in all directions from every point of her surface; whence, since a visual angle of a given magnitude includes a much larger portion of a spherical surface near the extremities of its apparent disk than towards the centre, and as the number of rays is proportional to the surface from which they proceed, it follows that the intensity of the moon's light ought to be greater near the border than at the centre of her disk. The reason why this is not the case with regard to the sun is, that a greater proportion of the rays are absorbed in passing through a greater extent of the solar atmosphere; but the moon, having no atmosphere, ought to be sensibly most brilliant near the circumference of her orb. The contrary is, however, the case; her light is greatest at the centre, and less intense towards the circumference, exactly as it ought to be on the supposition of its being occasioned by the reflection of the solar rays. With regard to the ingenious argument of Arago, it cannot be held to be conclusive till we become more certainly acquainted with the nature of the lunar substance. The only property which we can safely ascribe to it as yet is *density*: whether in its physical properties it resembles the substances with which we are acquainted, is a question hardly within the bounds of legitimate investigation.

The spots of the moon, affording grounds for conjectures relative to her physical constitution and the nature of her surface, have been observed with great interest since the discovery of the telescope; and as they are of some service in the observation of eclipses, astronomers have been at much pains to determine their selenographic positions. On account of their number, it has been found necessary to distinguish them by particular names. Riccioli designated the most conspicuous of them by the names of astronomers, and other eminent men. Hevelius gave them the names belonging to countries, islands, seas, and regions on the earth, without reference to situation or figure. The nomenclature of Riccioli has, however, been deservedly preferred by Schroeter and others who have particularly observed the phenomena of the lunar surface, and is now universally followed. Mayer gave a catalogue of 89 of the most remarkable of the spots, with their selenographic latitudes and longitudes referred to a first meridian, namely, that which passes through the

centre of the moon's apparent disk, perpendicular to the lunar equator, accompanied by an accurate map of her surface. Delineations of the lunar disk have also been given by Hevelius in his *Selenographia*; by Cassini, Russel, Schroeter, Lohrmann, and others. The engraving (fig. 47) which accompanies this article gives a pretty accurate view of the appearance of the moon in her mean libration.

The following table contains the selenographic positions of some of the principal spots. The sign + indicates a northern, and — a southern latitude.

No.	Riccioli's Names.	Long.	Lat.
1	Zoroaster	West 72°	+ 58°
2	Mercurius	67	+ 40
3	Petavius	64	— 24
4	Langrenus	62	— 8
5	Endymion	60	+ 53
6	Cleomedes	55	+ 26
7	Atlas	48	+ 47
8	Hercules	42	+ 48
9	Censorinus	32	0
10	Fracastorius	32	— 22
11	Possidonius	32	+ 31
12	Theophilus	27	— 12
13	Cyrillus	25	— 13
14	St Catharina	24	— 18
15	Menelaus	15	+ 16
16	Aristoteles	West 15	+ 50
17	Ptolomæus	East 2	— 10
18	Arzachel	3	— 20
19	Archimedes	5	+ 28
20	Tycho	10	— 43
21	Plato	10	+ 52
22	Pitatus	12	— 29
23	Eratosthenes	12	+ 14
24	Clavius	16	— 60
25	Copernicus	19	+ 9
26	Bullialdus	21	— 21
27	Blancanus	25	— 65
28	Heraclides	38	+ 41
29	Keplerus	38	+ 7
30	Gassendus	39	— 19
31	Aristarchus	48	+ 24
32	Hevelius	67	— 1
33	Schickardus	68	— 49
34	Grimaldus	East 68	— 5

That there are prodigious inequalities on the surface of the moon, is proved by looking at her through a telescope at any other time than when she is full; for then there is no regular line bounding the dark and illuminated parts, but the confines of these parts appear as it were toothed and cut with innumerable notches and breaks; and even in the dark part, near the borders of the enlightened surface, there are seen some small spaces enlightened by the sun's beams. Upon the fourth day after new moon there may be perceived some shining points, like rocks or small islands, within the dark body of the moon; but not far from the confines of light and darkness there are observed other little spaces which join to the enlightened surface, but run out into the dark side, which by degrees change their figure, till at last they come wholly within the illuminated face, and have no dark parts round them at all. Afterwards many more shining spaces are observed to arise by degrees, and to appear within the dark side of the moon, which, before they drew near to the illuminated portion of the disk, were invisible, being totally immersed in the shadow. The contrary is observed in the decreasing phases, where the lucid spaces which

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These phenomena render it certain that the surface of the moon is covered with mountains of a great height, with rocks or masses of unknown matter, but possessing the property of reflecting the sun's light. The height of the lunar mountains may be determined in the following manner.

Fig. 48.

Let ABO (fig. 48) be the illuminated hemisphere of the moon, SO the tangential solar ray, and consequently O one of the points of the circle which separates the enlightened from the obscure hemisphere. All the part OD will be in darkness; but if this part contain a mountain aM so elevated that its summit M reaches the solar ray SO, the point M will be enlightened. Now, if the line OM can be determined by observation, it will be easy to deduce the arc Oa, and thence the height of the mountain aM , in terms of the moon's radius. Let E be the place of an observer on the earth; draw the lines EM, EO, EC (C being the centre of the lunar orb), and Om perpendicular to EM. The distance of the moon from the earth being known, we have the distance EO: the angle OEM is measured by the micrometer; therefore Om, which is the projected distance of OM, is a given quantity. Now $OM = \frac{Om}{\cos. MOm}$; and since OEM is a

very small angle, EOm may be considered a right angle, consequently $MOm = MOE - 90^\circ$; therefore $OM = \frac{Om}{\cos. (MOE - 90^\circ)} = \frac{Om}{\sin. MOE} = \frac{Om}{\sin. EOS}$ that is,

the distance between the summit of the mountain and the illuminated part of the moon's disk is equal to the projected distance measured by the micrometer, divided by the sine of the moon's elongation from the sun. Suppose this distance $OM = n \cdot CO$; we shall then have $CM = CO \sqrt{1 + n^2}$, and the height of the mountain $aM = CO(\sqrt{1 + n^2} - 1) = \frac{n^2}{2} CO$ (neglecting in the

development of the radical the powers of n which are higher than the square). According to the observations of Hevelius, the greatest value of n is $\frac{1}{3}$, which gives the height of the mountain equal to $\frac{1}{358}$ of the semidiameter of the moon. Schroeter, who estimated the heights of the lunar mountains by measuring the projections of their shadows at the time the sun was near their horizon, makes it in some cases $\frac{1}{4}$. The highest mountains on the earth do not reach an elevation greater than $\frac{1}{1000}$ of the terrestrial radius; the lunar mountains, therefore, in proportion to the diameters of the earth and moon, are nearly five times higher than those of our globe. Their absolute height is above five English miles. It is easy to see that these determinations are susceptible of very little accuracy.

Not only is the moon's surface rendered irregular by high and precipitous mountains, but numerous cavities appear in every part of her surface, some of which, according to Schroeter, are upwards of four English miles in

depth, and forty in circumference at the orifice. An insulated mountain is frequently observed to rise in the centre of these enormous pits or caverns; and they are surrounded by high annular ridges, the masses of which would exactly fill the inclosed cavities. From this circumstance, it is probable that the elevations and hollows which abound on the surface of the moon have been produced by volcanic eruptions. Herschel imagined that he even observed volcanoes in activity. At the time of the new moon he perceived on different parts of her obscure disk three luminous points, resembling pieces of burning charcoal, covered with a thin coat of white ashes, one of which, by a comparison with the third satellite of Jupiter, appeared to be upwards of three miles in diameter. Their brilliancy continued during several days, undergoing variations altogether independent of the increase of the moon's apparent magnitude, and at the end of that time they appeared to become extinct.

The existence of a lunar atmosphere has been a fertile subject of controversy among astronomers. It has been urged that, as the brightness of the moon is sensibly equal at all times when she is not obscured by clouds in the terrestrial atmosphere, she cannot be surrounded by an atmosphere similar to that of our earth, so variable in its density, and so liable to be obscured by clouds and vapours. The assumption of an equable brightness in the appearance of the moon has not, however, been allowed to pass uncontroverted. Hevelius relates that he has several times found in skies perfectly clear, when even stars of the sixth and seventh magnitude were visible, that, at the same altitude of the moon, at the same elongation from the earth, and with the same telescope, the moon and her maculae do not appear equally lucid and clear at all times, but are much brighter and more distinct at some times than at others. Several other observers have noticed that the moon is not always equally conspicuous during total eclipses; a fact which is held to be indicative of accidental variations in the state of the lunar atmosphere.

Another objection against the existence of a lunar atmosphere is derived from the circumstance that, if it existed, its influence would be perceptible in the occultations of the planets, or fixed stars, by the moon. When the moon approaches so near to a star that part of her atmosphere (supposing she has one) is interposed between the star and the eye of the observer, the star, it is contended, ought to suffer a change in its colour in consequence of the absorption of some of its light in traversing the denser parts of the moon's atmosphere. But when we consider that the region of the vapours and clouds in the terrestrial atmosphere does not exceed the height of four miles, or the 1980th part of the earth's diameter, and that consequently the obscure part of the lunar atmosphere, supposing it to be similarly constituted, would not subtend an angle of one second (the mean apparent diameter of the moon being 1889 seconds), and that this space is passed over by the moon in less than two seconds of time, it will scarcely be expected that observation will be able to decide whether the supposed obscuration takes place or not. Some observers have, however, remarked instances of stars, when about to be occulted, presenting an evident diminution of light. (See a Paper by Mr Ramage of Aberdeen, in the 2d vol. of the *Memoirs of the Astronomical Society*.)

The existence of a lunar atmosphere cannot increase or diminish the apparent diameter of the moon, because its effect on the rays of light when they enter it will be exactly counteracted at the time of their emergence. It might seem, therefore, that in order to determine whether the light of a star or planet is inflected when it passes very near the

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border of the lunar disk, it would be sufficient to compare the observed duration of the occultations of the stars, or eclipses of the sun, with the time, calculated from the theory of the moon's motion, which she consumes in passing through a space equal to her apparent diameter. But if, as is generally supposed, a certain irradiation is produced around luminous objects, by which their image is dilated, the apparent diameter of the moon will thereby be augmented when she is projected on the dark sky. On the contrary, when the disk of the moon is projected on that of the sun in annular eclipses, the irradiation, by dilating the luminous ring which seems to surround the moon, will cause her apparent diameter to appear smaller than it actually is. On this account it becomes very difficult to ascertain by direct measurement the amount of the inflection of light at the border of the lunar disk, or even to be certain of its existence. An indirect method of arriving at the desired object was, however, imagined by Dionis du Sejour, who regarded the irradiation and inflection as two unknown quantities to be determined simultaneously from the observations of the phases of eclipses, upon which their effects are different. The observations best adapted for this purpose are those of the magnitude of the luminous crescent, and its successive increase in annular eclipses. Du Sejour calculated with great care the annular eclipse of the sun which took place in the year 1764, and was visible over all Europe; and which, by reason of the extent and variety of its phases, presented a great many points of comparison. He particularly employed the observations made in different places of the instants of the formation and rupture of the ring. He likewise confirmed these observations by measurements made by Mr Short, at London, of the distance between the horns of the crescent at divers instants. It resulted, from the comparison of an immense number of observations, that the measurements could not be reconciled without supposing an irradiation of 3" on the semidiameter of the sun, and an inflection of nearly the same amount round the disk of the moon, produced by her atmosphere. According to this result, the horizontal refraction at the surface of the moon amounts to 1".5. The mean horizontal refraction observed at the surface of the earth is 0".585, and consequently about 1400 times greater than that at the moon. Hence, supposing the moon's atmosphere of the same nature as that of the earth, its density must be 1400 times less, and consequently rarer than the most perfect vacuum which can be produced by the best pneumatic machines.

The existence of a lunar atmosphere, though of small extent, is indicated with considerable probability by the observations of Schroeter, who perceived that some ranges of lunar mountains, when in the dark hemisphere, are illuminated more feebly in proportion as they recede from the boundary of light and darkness; an effect which would be produced by the partial absorption of the rays of light which pass near the moon's surface. He also remarked the same circumstance with regard to the cusps, and perceived other indications of an atmosphere in some changes of tint, which induced him to think that a twilight might be discernible towards the cusps. With a view to prove the accuracy of this conjecture, he examined the moon with great care under the most favourable circumstances, and at length descried a faint glimmering which he took to be crepuscular light, ex-

tending from the cusps into the dark body of the moon. Its greatest breadth was 2"; and it extended 1' 20" from the cusps, along the circumference of the lunar disk. From these data he computed that the height of the lunar atmosphere, to the limit where it ceases to inflect the rays of light or diminish the brightness of a star, does not exceed 5742 English feet. A ring of this breadth, at the distance of the moon, will subtend an angle of only 0".94; hence the almost imperceptible influence of the lunar atmosphere.

Some observations, related by Mr Ramage of Aberdeen, in a memoir already alluded to, of occultations of Jupiter and his satellites, with an excellent reflecting instrument, also tend to confirm the existence of a small lunar atmosphere. On the approach of the satellites no diminution of their light was perceptible. On coming into contact with the moon's limb they did not disappear instantly, like fixed stars, but formed an indentation or notch in the limb, as if imbedded in it, but at the same time separated from it by a fine line of light. The indentation continued visible till about half their diameters were immersed, when it disappeared. (*Memoirs of the Astronomical Society of London*, vol. ii. p. 87.)

The dark spots on the moon's surface were formerly supposed to be water; but as elevations and cavities are distinctly perceptible in them, that hypothesis is evidently erroneous. Besides, the extreme tenuity of her atmosphere is inconsistent with the existence of water at her surface. It is only by the weight of the terrestrial atmosphere that the liquids at the surface of the earth are prevented from being dissipated in vapours. If the present atmosphere were removed, every liquid would continue to be dissipated in this manner till a new atmosphere was formed, to which each would contribute in proportion to its elastic force; and the evaporation would only cease when the tension of the vapour of each liquid was equal to its elastic force in a vacuum at the same temperature. But if the vapours were removed as they arose, by any absorbing cause, the evaporation would continue till the liquids entirely disappeared. Now we may suppose this to have been the case with respect to the moon, and that at one time she may have had an atmosphere, which the attractive force of the earth, aided by some accidental circumstance, may have swept away and united with our own. (Biot, *Astr. Phys.* tome ii. p. 413.)

Under these circumstances it is evident, that no animal, similarly constituted to those which inhabit the earth, could respire at the surface of the moon.¹ Every thing there appears solid, desolate, and unfit for the production and support of organized substances; and the excessive cold which certainly prevails must be sufficient to destroy every source of animal or vegetable life. May it not then be supposed that the moon is a planet which has not yet reached a state of maturity—a maturity to be prepared by successive volcanic eruptions; or that, having fulfilled its destiny, it is now in a state of decay?

On the subject of this section, see Hevelius, *Selenographia*; Schroeter, *Selenotopographische Fragmente*; Hooke's *Micrographia*, 1665; Lemonnier, *Selenographie*; Mayer, *Cosmographische Nachrichten*, 1748; Boscovich, *De Lunæ Atmosphæra*, 1753; Dunn, *Phil. Trans.*, 1762; Herschel, *Phil. Trans.*, 1780 and 1787, p. 229; Ferguson's *Astronomy*, by Brewster; Biot, *Astronomie*, tome ii. p. 413; Schubert, *Traité d'Astronomie Théorique*, tome ii. p. 364.

¹ It has always been a favourite opinion with mankind, that the celestial bodies, resembling the earth in some respects, are also, like it, peopled with rational beings. The author of the verses attributed to Orpheus ascribes to the moon many mountains, and cities, and palaces:

ἡ πολλὰ οὐρα ἔχει, πολλὰ ἀστία, πολλὰ μῆλα βρα.

SECT. VI.—Of Eclipses and Occultations.

In describing these interesting phenomena, we will first consider the eclipses of the moon, which, for any given place on the earth, are much more frequent than those of the sun, and, by reason of certain circumstances about to be explained, can also be computed with much greater facility.

1.—Eclipses of the Moon.

The earth being an opaque, round body, much smaller than the sun, must project behind it in space a conical shadow, limited by straight lines drawn from the extremities of the sun's disk to touch the surface of the earth. When the moon enters this shadow, and a portion of her disk is still enlightened by the sun, the enlightened part will necessarily have the form of a luminous crescent, the concavity of which is turned to the conical shadow of the earth; and this appearance will likewise be exhibited when the moon begins to emerge from the shadow. As she approaches towards the shadow, her light is not suddenly eclipsed, but passes insensibly through all the successive gradations of obscurity, till the darkness attains its greatest intensity. The reason of this will be easily comprehended by considering that when an opaque body is placed between an object and the sun, so as to conceal only a part of his disk, the object is then less enlightened than when none of the solar rays are intercepted; and this in proportion as more or less of the sun is concealed. Between full illumination and total obscurity there are consequently intermediate tints and gradations of light, which are denominated the *Penumbra*, in contradistinction to the *Umbra* which covers those places to which the sun's rays are completely intercepted. Let S and E (fig. 49) be the centres of the sun and earth, and ABB'A' any plane whatever passing through the axis SE, in which, let AB, A'B' be tangents to the sun and earth on opposite sides of the axis SE; these tangents will meet the prolongation of the axis in a point C. Let also AB', A'B touch the sun and earth on opposite sides of SE, and let C' be their intersection. If we now suppose the plane to turn round the axis SC, a conical shadow or umbra, of which the apex is C, will be formed behind BB'; and if the moon is situated within any part of the cone BCB', the sun will be entirely invisible. As soon as the moon emerges from this cone, a part at least of the sun's rays will fall upon her, and she will be in the penumbra. If situated, for example, at M, and MN be drawn to touch the earth and meet the solar disk in N, then the part of that disk between A and N will be visible at M. The extent of the penumbra is therefore determined by the angle DBC. When M is situated in the straight line BD, the whole of the sun's disk is visible; when M is in BC the sun entirely vanishes, and his visible portion diminishes from the instant M passes BD till it reaches BC. The intensity of the penumbra, therefore, goes on increasing from the first of these limits to the second, where it is confounded with the total darkness. This explains the progressive obscuration of the moon's disk in her eclipses.

If we now attempt to determine the circumstances under which an eclipse of the moon can take place, it is obviously necessary to inquire, in the first place, into the length of the conical shadow BCB'; for an eclipse can only happen on the supposition of its extending beyond the orbit of the moon. For this purpose let EF (fig. 50) be drawn parallel to AB, and meeting SA in F. We have then $\sin. ECB = \sin. SEF = \frac{SF}{SE} = \frac{SA - EB}{SE} = \sin. R - \sin. p$, R

being the apparent semidiameter of the sun, and p his horizontal parallax. By reason of the smallness of these angles

the arcs may be substituted for the sines; hence the angle

$$ECB = R - p. \text{ But } CE = \frac{EB}{\sin. ECB}, \text{ therefore making}$$

$$EB, \text{ the radius of the earth, } = a, CE = \frac{a}{\sin. (R - p)}.$$

From this expression it is evident that the value of CE depends on the horizontal parallax, and therefore varies with the sun's distance from the earth. On calculating, by means of the values of R, a , and p , given in the preceding sections, the values of CE at the perigean, mean, and apogean distances, the following results will be obtained:—

	Lengths of CE.
Sun in perigee.....	212.896 terrestrial radii.
at mean distance.....	216.531
in apogee.....	220.238

Now the greatest distance of the moon from the earth is less than 64 terrestrial radii (sect. ii.), consequently the shadow of the earth is projected into space between three and four times farther than the distance of the moon. Hence it appears, that if the moon moved in the ecliptic she would traverse the earth's shadow and be eclipsed every revolution. On account of the inclination of her orbit to that plane, the eclipses can only happen when she is in or near her nodes. The greatest distances from the nodes at which they can take place are called the *Lunar Ecliptic Limits*.

In order to determine these limits, it is necessary first of all to know the apparent diameter of a section of the earth's shadow, at the place where it is traversed by the orbit of the moon. Let lMl' (fig. 50) be a part of the moon's orbit, intersecting the lines AC and A'C in m and m' ; then mm' is the geocentric diameter of the shadow, the half of which is measured by the angle mEC . Now the angle mEC is the difference between the angles EmA and ECA , the first of which, namely, EmA , is the apparent semidiameter of the earth seen from the moon, or, in other words, the moon's horizontal parallax. Let this angle, therefore, be denoted by P . It has already been shown that $ECA = R - p$; consequently we have $mEC = P + p - R$ in all cases; that is to say, *the semidiameter of the shadow is equal to the sum of the horizontal parallaxes of the sun and moon, diminished by the apparent semidiameter of the sun*. On calculating the amount of this expression from the values of P and p given above, the following table will be obtained, exhibiting the magnitude of the apparent diameters of the earth's shadow for different distances of the sun and moon.

	Apparent diameters of earth's shadow.
Sun in perigee,	in apogee.....1° 15' 24".30
	at mean distance 1 23 2.31
	in perigee.....1 30 40.31
Sun at mean distance,	in apogee.....1 15 56.86
	at mean distance 1 23 34.87
	in perigee.....1 31 12.87
Sun in apogee,	in apogee.....1 16 28.29
	at mean distance 1 24 6.30
	in perigee.....1 31 44.30

The greatest apparent diameter of the moon being only 33' 31".07, which is about a third part of the diameter of the earth's shadow, it follows that the moon may not only be completely enveloped in the shadow, but, since she passes over a space nearly equal to her own breadth in an hour, that she may continue to be totally eclipsed during a space of about two hours.

The above determination refers only to the umbra or cone of total darkness; but the diameter of the penumbra is obtained in a manner exactly similar. In the same

Theoretical diagram the semidiameter of the penumbra is measured by the visual angle $\angle EC$; but $\angle EC = \angle IC' + \angle EC'$, and $\angle EC' = \angle EC'' = \angle CEA + \angle CAE$; therefore $\angle EC = \angle IC' + \angle CEA + \angle CAE$; or, retaining the same denominations as above, $\angle EC = P + p + R$. Hence, the semidiameter of the penumbra is equal to the horizontal parallaxes of the moon and sun, augmented by the apparent semidiameter of the sun.

All the different numerical values of the semidiameter of the penumbra corresponding to particular positions of the sun and moon may be computed exactly in the same manner as in the case of the umbra.

The two expressions for the semidiameters of the umbra and penumbra, viz. $P + p - R$, and $P + p + R$, give immediately the distance of the moon's centre from the axis of the cone when her disk comes into contact with the shadow. Representing the apparent semidiameter of the moon by r , her disk will just touch the umbra when the distance of her centre from the axis SE is equal to $P + p - R + r$; and it will touch the penumbra when the distance is $P + p + R + r$. But on account of the very feeble obscurity of the penumbra towards its extreme border, it is impossible to observe with any degree of precision the time at which the moon enters it. In computing the ecliptic limits, therefore, it is only necessary to have regard to the umbra.

In the table given above, the extreme values of $P + p - R$, the apparent semidiameter of the earth's shadow, are $\frac{1}{2} (1^\circ 15' 24'' \cdot 30) = 37' 42'' \cdot 15$, and $\frac{1}{2} (1^\circ 31' 44'' \cdot 30) = 45' 52'' \cdot 15$; and the least and greatest values of r , the apparent semidiameter of the moon, are respectively $14' 45''$ and $16' 45''$ (sect. ii.); therefore the least distance of the moon's centre from the axis of the shadow at the time of her immergence or emergence is $37' 42'' \cdot 15 + 14' 45'' = 52' 27'' \cdot 15$, and the greatest $45' 52'' \cdot 15 + 16' 45'' = 62' 37'' \cdot 15$. The first is the limit within which an eclipse must necessarily happen; the last that beyond which it cannot happen.

It is now easy to ascertain the limits of the moon's distance from her node, within which the eclipses take place. Let NC (fig. 51) be a portion of the ecliptic, NM part of the moon's orbit, N its node, C the centre of a section of the earth's shadow, M the centre of the moon; the verge of the lunar disk touching, but not penetrating, the shadow at a . It is evident that, if the moon be at a greater distance than CM from NC , there can be no eclipse. The greatest value of CM , as we have just seen, is $62' 37'' \cdot 15$, from which the corresponding ecliptic limit NC is easily computed by means of the formula

$$\text{rad.} \times \sin. CM = \sin. NC \times \sin. CNM.$$

Supposing the angle CNM , that is, the inclination of the moon's orbit to the ecliptic, to be 5° , which is its minimum value, the value of NC is found from the logarithmic tables to be $12^\circ 2'$ nearly. Hence an eclipse of the moon can only happen when she is within about $12^\circ 2'$ of her node. Under the most favourable circumstances, however, the limits may extend to $13^\circ 21'$. A lunar eclipse will certainly take place if the moon's distance from her node, at the time of her mean opposition, is not greater than $7^\circ 4'$.

When the moon's disk only comes into contact with the shadow, as in fig. 51, the phenomenon is called an *appulse*; when the disk only enters into the shadow in part, the eclipse is said to be *partial*; it is called *total* if the moon entirely disappears, and *central* when her centre coincides with the axis of the cone, or if at the time of the eclipse the moon is exactly in her node.

In the preceding determinations the shadow has been supposed to be conical, whereas, on account of the compression of the earth at the poles, it is not exactly a cone, but a conoid on an elliptic base; and it varies at every in-

stant by reason of the earth's rotation. To determine rigorously the figure of the cone at every instant, and the diameter of its section where the moon enters and leaves it, would require calculations of great complication and prolixity. Such precision is, however, unnecessary; and indeed it is impossible to attain to absolute accuracy so long as the figure of the earth is not exactly known. It is usual and natural to employ the largest diameter which the shadow can have at the distance of the moon.

It has also been supposed that the shadow is terminated by tangents to the sun and the earth; that is to say, that all the rays of light which are not obstructed by the globe of the earth pass in straight lines from the sun to the moon. But the earth being surrounded by an atmosphere which near the surface exerts a powerful action on the solar rays, it is to be presumed that those rays which, if unobstructed, would glance by the surface of the earth, are absorbed by the lower strata of the atmosphere. The effect of this will be to enlarge the diameter of the shadow; and the requisite correction may be regarded as an augmentation of the earth's radius, by adding to it a part of the atmosphere; or, which amounts to the same thing, an augmentation of the lunar parallax. Now, it is found by experience that such a correction is necessary; and, according to Mayer, the lunar parallax must be augmented by a 60th part in order to satisfy the observations.

Another effect of the action of the earth's atmosphere on the solar rays is to render the moon dimly visible even when she is totally eclipsed,—a circumstance to which allusion was made in the preceding section. Let the circle fgh (fig. 52) concentric to the earth include that part of the atmosphere which is sufficiently dense to produce a sensible refraction of the rays of light. All those rays which do not fall within that circle, such as Wfw , Vv , proceed in their direct course without suffering any refraction; but those which enter the atmosphere between f and h , and between i and l , on opposite sides of the earth, are gradually more bent inward as they go through a greater portion of the atmosphere, until the rays Wk and Vl , touching the earth at m and n , are bent so much as to meet at q , a little short of the moon; and therefore the dark shadow of the earth is contained in the space $mopqm$, where none of the sun's rays can enter; all the rest, R, R , being mixed by the scattered rays which are refracted as above, is in some measure enlightened by them; and some of those rays falling on the moon, give her the colour of tarnished copper, or of iron almost red-hot; so that if the earth had no atmosphere, the moon would be as invisible in total eclipses as she is when new. If the moon were so near the earth as to go into its dark shadow, suppose about p or q , she would be invisible during her stay in it, but visible before and after in the fainter shadow RR .

After having pointed out the general phenomena of the lunar eclipses, and the limits within which they take place, it only remains to show in what manner the time of their commencement, end, and duration, and also their magnitude, may be determined by computation.

Let the line NE (fig. 53) represent the ecliptic, NO the orbit of the moon, C the centre of the terrestrial shadow, and M the centre of the moon at the instant of the opposition; then CM will be the circle of latitude on which the opposition takes place. The centre of the shadow C being always in opposition with the sun, moves along the ecliptic from west to east, or from N towards E , with the same velocity as the sun. The moon also, at the same time, moves in her orbit from west to east, or from N towards O . Now the velocities of these two motions are given by the astronomical tables, and the question is to determine the instant of time at which the circles

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At the time of an eclipse the apparent distance of the centre of the shadow from the moon is very small, consequently CM, and also the differences of the respective longitudes and latitudes of C and M, may be regarded as straight lines. During the short interval between the commencement and end of an eclipse, the motion of the sun, and consequently that of the centre of the shadow, may likewise be regarded as uniform. By these suppositions, sufficiently accurate for our present purpose, the problem is considerably simplified.

Suppose now that C' and M' are two simultaneous positions of the shadow and moon at any instant before or after the opposition. Let M'P be perpendicular, and MQ parallel, to NE. The velocities of the moon and terrestrial shadow being known from the tables, the lines C'P and QM', which represent the motions of the centre of the moon relatively to that of the shadow in longitude and latitude, are known also; whence C'P and P M' are given, and consequently C' M' the distance of the centres. Let us assume

- λ = CM or λ 's latitude when in opposition,
- s = $\odot$'s motion in longitude,
- m = λ 's horary motion in longitude,
- n = λ 's motion in latitude,
- t = time from M to M',
- c = C'M' the distance of the centres.

Now, since we suppose that CP and QM' are the λ 's motion in longitude and latitude respectively in the time t , it is evident that CP = mt , and QM' = nt . But CC' is the sun's motion, or the motion of the terrestrial shadow in longitude during the same time; therefore CC' = st . We have then C'P = $mt - st$, and PM' = $\lambda + nt$; consequently

$$c^2 = (mt - st)^2 + (\lambda + nt)^2.$$

In this quadratic equation, if t is regarded as the unknown quantity, the only arbitrary quantity contained in it will be c , the distance of the centres, the others being all determined from the tables. On assigning, therefore, any arbitrary value to c , the resolution of the equation will give the corresponding value of t , and consequently the circumstances or different phases of the eclipse which we may wish to determine.

On arranging the terms of the above equation so as to obtain the resolution relatively to t , we have

$$[(m - s)^2 + n^2] t^2 + 2\lambda nt = c^2 - \lambda^2,$$

which may be still simplified by introducing an auxiliary angle θ , such that $\tan. \theta = \frac{n}{m - s}$; for by this substitution there will result

$$n^2 t^2 + 2\lambda nt \sin. \theta = (c^2 - \lambda^2) \sin. \theta,$$

which gives the two following values of t :

$$t = \frac{1}{n} \left(-\lambda \sin. \theta \pm \sin. \theta \sqrt{c^2 - \lambda^2 \cos. \theta} \right).$$

The first of these denotes the time at which the moon enters, and the second that at which she quits, the umbra or penumbra.

The time at which the different phases of the eclipse happen, are calculated directly from this equation. If, for example, we wish to determine the time at which the moon's disk begins to enter the shadow, we make $c = P + p - R + r$ (neglecting the small augmentation of the shadow occasioned by the refraction of the atmosphere). In the case of the penumbra we must take $c = P + p + R + r$; and it is evident that, if in either case λ is of such a magnitude that c is less than $\lambda \cos. \theta$, the value of t will be impossible; in other words, no eclipse can take place.

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If we suppose $P + p - R + r = \lambda \cos. \theta$, the two values of t will be equal, and the duration of the phase will only be for an instant, as in the case of the appulse, in which the moon's limb just touches the shadow without entering it. In general, the portion of the diameter of the eclipsed part is $P + p - R + r - \lambda \cos. \theta$; and consequently the diameter of the part not eclipsed is equal to the diameter of the moon, or $2r$, minus this quantity, that is, equal to $\lambda \cos. \theta - P - p + R + r$. When this expression is equal to nothing the eclipse is just a total one; when negative, the upper boundary of the moon's limb will be under the upper boundary of the section of the shadow, and the total eclipse will continue for some time.

The instant at which the middle of the eclipse happens will evidently be that at which the two values of t are equal, or when the radical disappears, that is, when $c =$

$\lambda \cos. \theta$. In this case $t = -\frac{1}{n} \lambda \sin. \theta$, and the instant is

called that of the *greatest phase*. It is usual to express the quantity of the eclipse in digits, or twelfths of the lunar diameter; so that the eclipsed part is represented

by $\frac{12}{2r} (P + p - P + r - \lambda \cos. \theta)$. Thus, taking the moon's apparent diameter at $33' 18''$, and supposing the eclipsed part to be $24' 52''$, this part expressed in digits will be $\frac{24' 52''}{33' 18''} \times 12 = 8.96$ digits.

The obscurity of the penumbra renders observations of the commencement and termination of the lunar eclipses extremely uncertain. To obviate in some degree this inconvenience, care is taken to observe as accurately as possible the instants at which the shadow arrives at or passes different known spots on the moon's disk; so that the same eclipse offers in fact a great number of different observations, the mean of which may be regarded as more certain than any individual one. But after all the precautions that can be taken, the eclipses of the moon are far from affording results equally precise and certain as those of the sun. They were formerly of much greater importance than they are in the present state of astronomy; for the ancients had no other means of determining the geographical longitudes of places on the earth. In fact, as the eclipse is occasioned by the moon's being deprived of her light, the different phases of the eclipse happen at exactly the same physical instant of time to all observers to whom the moon is visible. The difference of the time reckoned by two observers at the instant of the phenomenon will therefore give the difference of the horary angles, or of their meridians; but supposing each to have made a mistake of 4 minutes of time in an opposite sense (and the ancients could scarcely guarantee a greater degree of accuracy), the resulting error in the difference of longitude would amount to 2° . The geographical tables of Ptolemy contain errors of still greater magnitude.

2.—Eclipses of the Sun.

The eclipses of the sun are caused by the interposition of the moon between the sun and the earth, and their general phenomena may be explained in the same manner as those of the moon. When the conical shadow which the moon projects behind her in space reaches the earth, those points of the earth's surface on which it falls are completely deprived of the light of the sun, and involved in total darkness. Those parts of the earth which are covered by the penumbra are only partially deprived of the sun's light, because the moon does not conceal the whole, but only a part of the solar disk.

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In order to appreciate the different circumstances of a solar eclipse, the procedure to be adopted is in many respects the same as that which has been explained in regard to the eclipses of the moon. The length of the moon's shadow, the first object of inquiry, is found exactly in the same manner as that of the earth; and it is only necessary to substitute in the formulæ already given the values of the apparent diameter and parallax of the sun which they would have at the surface of the moon. Now, these values are easily found, for the diameter of the sun as seen from the moon is equal to his diameter as seen from the earth, increased in the ratio of the distances of the moon and earth from the sun. In the same manner the parallax of the sun relatively to the moon is equal to his parallax relatively to the earth, augmented in the ratio of the distances, and diminished in the ratio of the diameters, of the moon and earth. Thus, let D represent the distance of the earth from the sun, d the moon's distance from the sun, m the moon's true semidiameter, and a the semidiameter of the earth; the sun's apparent semidiameter as seen from the moon will be $R \cdot \frac{D}{d}$ (R being his apparent semidiameter as seen from the earth), and his horizontal parallax will be $p \cdot \frac{D}{d} \cdot \frac{m}{a}$. The formula then which expresses the length of the terrestrial shadow CE (fig. 50), namely, $\frac{a}{\sin. (R - p)}$, adapted to the case of the moon, becomes $\frac{m}{\sin. \left\{ \left(R - p \cdot \frac{m}{a} \right) \frac{D}{d} \right\}}$, and expresses the distance be-

tween the centre of the moon and the apex of her shadow. By means of this formula the following results, which refer to the extreme cases in which the length of the shadow is a maximum and minimum comparatively with the moon's distance from the earth, may be computed.

	Length of shadow.	Moon's distance.
Sun in apogee, Moon in perigee,	59-730	55-902
Sun in perigee, Moon in apogee,	57-760	63-862

In the first case the shadow of the moon will reach beyond the centre of the earth; in the second it will not reach even to the surface. It follows, therefore, that even if the orbit of the moon coincided with the ecliptic, she would not produce a total obscurity every time she comes between the sun and the earth. At her greatest distances, where the shadow does not reach the earth, the effect of her interposition would be to conceal only a part of the sun's disk.

By introducing into the other formulæ modifications similar to the above, we shall find the apparent diameter of the shadow and the solar ecliptic limits. The apparent semidiameter of the earth's shadow has been shown to be equal to $P + p - R$; consequently the semidiameter of the lunar shadow at the distance of the earth, as seen by an observer placed on the moon, is equal to the parallax of the earth, plus the parallax of the sun relatively to the moon, minus the apparent semidiameter of the sun seen from the moon. The parallax of the earth means simply the apparent semidiameter of the moon seen from the earth; and if we neglect the parallax of the sun, which cannot influence the result to the extent of half a second, we shall have the following theorem: *The semidiameter of the lunar shadow is equal to the excess of the apparent semidiameter of the moon above the apparent semidiameter of the sun.* Hence, denoting the moon's apparent semidiameter by r , the semidiameter of the lunar shadow will be expressed by $r - R \cdot \frac{D}{d}$; or,

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taking into account the sun's parallax, $r + p \cdot \frac{m}{a} \cdot \frac{D}{d} - R \cdot \frac{D}{d}$. The ratio of the distances $\frac{D}{d}$, in this and the preceding formula, may be expressed in terms of the parallaxes; for since $p = \frac{a}{D}$, and $P = \frac{a}{D - d}$, therefore $\frac{D}{d} = \frac{P}{P - p}$. Since also $\frac{m}{a} = \frac{r}{P}$, according to the nature of parallax, we have likewise $r + p \cdot \frac{m}{a} \cdot \frac{D}{d} = \frac{r \cdot P}{P - p}$; therefore, by substituting these values, the expression for the semidiameter of the lunar shadow becomes

$$(r - R) \cdot \frac{P}{P - p}.$$

If to the apparent semidiameter of the shadow at the point where it is touched by the earth, we add the apparent semidiameter of the earth as seen from the moon, that is to say, the moon's horizontal parallax (P), the distance between the centres of the moon's shadow and of the earth will be

$$P + (r - R) \cdot \frac{P}{P - p},$$

from which expression the solar ecliptic limits may be readily computed. The result of the computation is, that a solar eclipse may take place if the moon's distance from her node, at the time of her mean conjunction with the sun, does not exceed $19^\circ 44'$. If her distance from the node is less than $13^\circ 33'$, the sun will certainly be eclipsed in some part of the world.

The solar eclipses present a great variety of appearances, depending on the relative positions of the sun, the moon, and the spectator. If the apparent diameter of the moon happens to surpass that of the sun, the eclipse will be *total*; but if the moon's diameter be the smaller, the observer will see a luminous ring, formed by that part of the sun's disk which exceeds that of the moon, and the eclipse will in that case be *annular*. If the centre of the moon is not in the same straight line which joins the observer and the centre of the sun, the eclipse can only be *partial*, as the moon can only conceal a *part* of the sun's disk. When the moon merely touches without penetrating the solar disk, the phenomenon is called an *appulse*; and the eclipse is *central* if the observer is placed at the centre of the shadow, on the straight line joining the centres of the sun and moon.

When the change happens within 17 degrees of the node, and the moon is at her mean distance from the earth, the point of her shadow just touches the earth, and she eclipses the sun totally to that small spot whereon her shadow falls; but the darkness is not of a moment's continuance.

The moon's apparent diameter, when largest, exceeds the sun's, when least, only two minutes of a degree; so that in the greatest eclipse of the sun that can happen at any time and place, the total darkness continues no longer than whilst the moon passes over two minutes in her orbit, that is, about 3 minutes and 56 seconds of an hour.

The moon's shadow covers only a spot on the earth's surface about 180 English miles broad, when her diameter appears largest, and the sun's least; and the total darkness can extend no farther than the limits of the dark shadow. Yet the partial shadow or penumbra may then cover a circular space 4900 miles in diameter, within all which the sun is more or less eclipsed, as the places are less or more distant from the centre of the penumbra. When the moon changes exactly in the node, the penumbra is circular on the earth at the middle of the general eclipse, because at

Extent of
the moon's
shadow and
penumbra.

Theoretical Astronomy. that time it falls perpendicularly on the earth's surface; but at every other moment it falls obliquely, and will therefore be elliptical; and the more so as the time is longer before or after the middle of the general eclipse; and then much greater portions of the earth's surface are involved in the penumbra.

To make several of the above and other phenomena plainer, let *S* (fig. 52) be the sun, *E* the earth, *M* the moon, and *AMP* the moon's orbit. Draw the straight line *Wc* from the western side of the sun at *W*, touching the western side of the moon at *c*, and the earth at *e*: draw also the straight line *Vd* from the eastern side of the sun at *V*, touching the eastern side of the moon at *d*, and the earth at *e*: the dark space *ced* included between these lines is the moon's shadow, ending in a point at *e*, on the surface of the earth, because in this figure the moon is supposed to be at her mean distance from the earth. Had the moon been in her perigee, the shadow would have covered a space on the surface of the earth of about 180 miles in diameter, to all places within which space the eclipse would have been total. Had she been in her apogee, the shadow would have terminated in a point above *e*, and to an observer at *e* the sun would have been eclipsed annularly. Draw the straight lines *WXdh* and *VXcg*, touching the contrary sides of the sun and moon, and ending on the earth at *a* and *b*; draw also the straight line *SXM* from the centre of the sun's disk, through the moon's centre to the earth, and suppose the two former lines *WXdh* and *VXcg* to revolve on the line *SXM* as an axis, and the points *a* and *b* will describe the limits of the penumbra *TT* on the earth's surface, including the large space *aba*, within which the sun appears more or less eclipsed, according as the places are more or less distant from the verge of the penumbra *ab*.

Draw the right line *y* 12 across the sun's disk, perpendicular to *SXM* the axis of the penumbra; then divide the line *y* 12 into twelve equal parts, as in the figure, for the twelve digits or equal parts of the sun's diameter; and at equal distances from the centre of the penumbra at *e* (on the earth's surface *YY*) to its edge *ab*, draw twelve concentric circles.

To an observer on the earth at *b*, the eastern limb of the moon at *d* seems to touch the western limb of the sun at *W* when the moon is at *M*, and the sun's eclipse begins at *b*; but at the same moment of absolute time, to an observer at *a*, the western edge of the moon at *c* leaves the eastern edge of the sun at *V*, and the eclipse ends. At the very same instant, to all those who live on the circle next to *ab*, the moon cuts off or darkens a twelfth part of the sun, and eclipses him one digit; to those who live on the next interior circle, the moon cuts off two twelfth parts of the sun; to those on the following circle, three parts; and so on to the centre at *e*, where the sun is centrally eclipsed. The different appearances of the eclipse, as seen by spectators in these different situations, with regard to the centre of the shadow, are represented in fig. 54, under which figure there is a scale of hours and minutes, to show at a mean state how long it is from the beginning to the end of a central eclipse of the sun on the parallel of London, and how many digits are eclipsed at any particular time from the beginning at *A* to the middle at *B* or the end at *C*. Thus, in 16 minutes from the beginning, the sun is two digits eclipsed; in an hour and five minutes, eight digits; and in an hour and 37 minutes, 12 digits.

Having determined the diameter of the moon's shadow at the earth, and the limits within which eclipses of the sun can take place, the next object is to determine the time of their commencement and termination. If the

position of the observer were on the moon instead of the surface of the earth, our solar eclipses would appear to him as eclipses of the earth, and they would commence at the instant when the earth's disk began to penetrate the lunar shadow. A spectator so situated might therefore compute all the circumstances of a terrestrial eclipse in exactly the same manner in which we compute those of the moon; the same formulæ would suffice, with the slight modifications which have already been made. But relatively to an observer placed on the earth the case is altogether different. To him the eclipse does not begin when the moon's shadow comes into contact with the earth's disk, but when it begins to obscure his station. This, therefore, is one circumstance which renders the computation of solar more complicated and difficult than that of lunar eclipses; for it is necessary not only to determine generally what portion of the terrestrial disk is covered by the shadow, but also its position relatively to the equator and to a given meridian, and likewise the path described by the centre and contour of the umbra and penumbra on the surface of the earth. There is another circumstance which still further augments the difficulty of the computation, namely, the position of the observer, on account of which it is necessary to introduce the particular conditions which depend on the parallax. In the case of a lunar eclipse, it is only necessary that the moon's disk enter the earth's shadow in order that the eclipse may be visible to any part of the terrestrial hemisphere opposite to the moon; but a solar eclipse may happen in some parts of the earth without being visible at others—a circumstance which is occasioned entirely by parallax.

When we abstract from the effects of parallax, or suppose the observer to be placed at the centre of the earth, the problem of determining the different circumstances of a solar eclipse is exactly the same as that relative to an eclipse of the moon. But when the spectator is supposed to be placed at the surface, the latitudes and longitudes corresponding to his situation are different from the geocentric latitudes and longitudes; and in order to adapt the formula from which the time is given to these new circumstances, it is necessary, as a preliminary step, to compute the corrections which must be applied in consequence of the effects of parallax in longitude and latitude. The chief circumstance, therefore, in which the calculation of solar eclipses differs from that of lunar, consists in its being necessary to compute the effect of parallax in the direction of the angular distances which form the data of the problem, in order to apply the requisite correction to the values of those distances furnished by the tables. The development of these computations belongs to Practical Astronomy.

The sun's ecliptic limits exceeding $17^{\circ} 21'$, while those of the moon are only $11^{\circ} 26'$, it follows that the eclipses of the sun must be much more frequent than those of the moon. Yet the lunar eclipses being visible to every part of the terrestrial hemisphere opposite to the sun, and those of the sun visible only to the small portion of the hemisphere on which the moon's shadow falls, it happens that for any particular place on the earth the lunar eclipses are much more frequently visible.

In any year the number of eclipses of both luminaries cannot be less than two, nor more than seven: the most usual number is four, and it is very rare to have more than six; for the sun passes through both the nodes but once a year, unless he passes through one of them in the beginning of the year; and if he does, he will pass through the same node again a little before the year is finished; because, as these points move $19\frac{1}{3}$ degrees backwards every year, the sun will come to either of them 173 days after the other; *Number of eclipses in a year.*

Theoretical and when either node is within 17 degrees of the sun Astronomy. at the time of new moon, the sun will be eclipsed. At the subsequent opposition, the moon will be eclipsed in the other node, and come round to the next conjunction again ere the former node be 17 degrees past the sun, and will therefore eclipse him a second time. When three eclipses take place about either node, the like number generally happens about the opposite, as the sun comes to it in 173 days afterwards; and six lunations contain but four days more. Thus, there may be two eclipses of the sun and one of the moon about each of her nodes. But when the moon changes in one of the nodes, she cannot be near enough the other node at the next full to be eclipsed; and in six lunar months afterwards she will change nearer the other node: in these cases there can be but two eclipses in a year, and they are both of the sun.

The eclipses of the sun being of great importance for the determination of geographical longitudes, it is of consequence to be in possession of some easy method of assigning the time at which they may be expected to occur, in order to avoid the necessity of long and tedious calculations. This may be done in a very simple manner, by considering that if a time can be assigned after which the sun and moon occupy exactly or nearly the same positions with regard to the nodes of the lunar orbit, their motions after that interval will recommence under the same circumstances, and the eclipses be reproduced in the same order. Now, it has been shown (chap. iii. sect. 2) that the nodes of the lunar orbit retrograde at the rate of $19^{\circ}3286$ in a year, consequently the time in which the sun returns to the moon's node is that which he requires to describe an arc of $360^{\circ} - 19^{\circ}3286$, or, as is found by a simple proportion, 346.619851 days. On comparing this with 29.5305887 days, the time of a lunation, it will be observed that these numbers are nearly in the ratio of 223 to 19, so that after 223 synodic revolutions the moon has returned 19 times to the same position relatively to the sun. But 223 synodic revolutions are completed in 18 mean solar years and 10 or 11 days, consequently after that interval all the eclipses, whether of the sun or the moon, return again in nearly the same order; which gives a very simple means of predicting them, since only 18 years of observation are required. This period was known to the astronomers of the remotest ages, and is generally supposed to be that which the Chaldeans distinguished by the name of *Saros*. (See PART I. of this article.)

But the ratio of 223 to 19 is not exact, and it is besides subject to variation from the secular inequalities of the sun and moon, by reason of which the rates of their mean motions are sensibly changed. Discordancies will hence arise; and in the course of time the order of eclipses observed in one of these periods will require correction. But the variations are slow and gradual; the lunisolar periods may, therefore, continue to be employed when approximative results only are required. When rigorous accuracy is wanted, recourse must be had to computation from the astronomical tables.

Occulta-
tions.

Occultations of planets and stars by the moon are phenomena of which the calculation depends on exactly the same principles, and is even made by the help of the same formulæ, as the eclipses of the sun. Let E (fig. 55) denote the centre of the earth, M that of the moon, and S a star or planet concealed by the moon; the straight line SM will represent the axis of the lunar shadow, that is to say, the portion of space which the rays proceeding from the star cannot reach in consequence of their being intercepted by the moon; and the angle EMO (EO being perpendicular to SM) will be the apparent distance of the centre of the shadow from the centre of the earth.

The expression for this angle in a function of the time is Theoretical obtained in exactly the same manner as in solar eclipses; Astronomy. and by equating it with the different values of the angle which correspond to the different phases of the occultation, and regarding the time as the unknown quantity, the epochs will be obtained at which the phases take place. There is only one circumstance which renders a slight modification of the formulæ necessary. In computing the angle SEM, or the apparent distance of the centres of the star and moon seen from the centre of the earth, that distance may be regarded in solar eclipses as the hypotenuse of a right-angled triangle, the sides of which are respectively the latitude of the moon, and the difference between the longitudes of the moon and sun. But in occultations of the planets or stars, the star may be out of the ecliptic, and consequently its latitude not zero; so that the sides of the right-angled triangle, of which the apparent distance of the centres is the hypotenuse, are the difference of latitude of the star and moon, and the difference of longitude reduced to the moon's place, that is to say, multiplied by the cosine of the moon's latitude. It is evident that any of the planets may suffer an occultation by the moon; but with regard to the fixed stars, it is only those which are situated at a distance from the ecliptic not greater than the moon's extreme latitude, that can ever be hid by the interposition of the lunar disk.

The following is a list of all the solar eclipses that will be visible in this country during the present century. The time of the commencement of the eclipse, and the number of digits eclipsed, are computed for the middle of England. (See Baily's *Tables*, &c. p. 52.)

LIST OF SOLAR ECLIPSES.				
Year.	Day and Hour.			Digits Eclipsed.
1832	July	27 ^a	2 ^h P. M.	0° 30'
1833	July	17	5 A. M.	9 36
1836	May	15	2 P. M.	11 18
1841	July	18	3 P. M.	contact
1842	July	8	5 A. M.	8 54
1845	May	6	8 A. M.	6 15
1846	April	25	6 P. M.	2 21
1847	October	9	6 A. M.	11 0
1851	July	28	2 P. M.	9 43
1858	March	15	11 A. M.	11 30
1860	July	18	2 P. M.	9 12
1861	December	31	2 P. M.	5 0
1863	May	17	6 P. M.	3 46
1865	October	19	4 P. M.	7 36
1866	October	8	5 P. M.	5 3
1867	March	6	8 A. M.	8 42
1868	February	23	3 P. M.	contact
1870	December	22	11 A. M.	9 36
1873	May	26	8 A. M.	3 43
1874	October	10	9 A. M.	6 18
1875	September	29	noon	0 33
1879	July	19	7 A. M.	4 0
1880	December	30	2 P. M.	4 24
1882	May	17	6 A. M.	2 18
1887	August	19	3 A. M.	11 58
1890	June	17	8 A. M.	4 39
1891	June	6	5 P. M.	3 0
1895	March	26	9 A. M.	1 0
1896	August	9	sunrise	contact
1899	June	8	5 A. M.	3 13
1900	May	28	3 P. M.	8 0

SECT. I.—General Phenomena of the Planetary Motions.

Having now described the motions and explained the phenomena of the sun and moon, our attention will be next occupied by the planets, those no less interesting bodies, whose remarkable peculiarities of apparent motion have attracted the curiosity, and formed a principal object of the labours, of astronomers in all ages. The sun and moon move among the stars always in the same direction, and with velocities nearly uniform; but the planets, though their apparent motions are most frequently from west to east, sometimes appear to have no proper motions, or to remain stationary among the fixed stars; at other times they appear to move in a contrary direction, or to retrograde; and hence the earth cannot be the centre of the planetary orbits. The determination of that centre, and the order of distance in which the orbits of the different planets are placed around it, is comparatively an easy task since the telescope and micrometer have made us acquainted with the phases and variations of the apparent diameters of the planets; but the ancients, who were guided by the apparent motions alone, found greater difficulty in extricating the elements of their theories from observations, and in framing hypotheses by which the phenomena could be represented with tolerable accuracy. The different hypotheses which have been proposed for this purpose are called, with sufficient impropriety, *Systems of the World*.

In order to obtain a general notion of the path traced by a planet in the heavens, it is necessary to attend closely to the various phenomena which it exhibits. As an example, we may take Venus, the most brilliant and remarkable of all the planets.

A slight attention to the position of Venus, continued a few days, suffices to show that she changes her place with considerable rapidity among the fixed stars. If we observe her in the evening, we shall soon find that her greatest distance from the sun never exceeds an arc of about 47° ; that after attaining this distance she begins again to approach the sun, the time which she continues above the horizon after sunset gradually diminishing, till at last she sets simultaneously with the sun, and is lost in the effulgence of his rays. From the circumstance of her appearing in the evening, and not remaining visible more than about three hours after the sun has descended below the horizon, Venus has obtained the name of *Εσπερος*, Hesperus, or the evening star; sometimes also she is called the shepherd's star.

A few days after the evening star has disappeared, a brilliant star is observed in the morning preceding the sun in the east, which was not seen while Venus followed him in the west. At first it rises only a few minutes before the sun, but every succeeding morning somewhat earlier, till its distance from him is between 45 and 47 degrees. It then begins gradually to fall back; its elongation or distance from the sun becomes less and less, till it approaches so near to him as to be again lost in his rays. This has been called *Φωσφορος*, Lucifer, or the morning star.

Hesperus and Lucifer were long regarded as different stars. It could not fail, however, to be remarked, that during the time the first continues to shine in the evening, the other is invisible in the morning, and as soon as the bright harbinger of day makes its appearance, the evening star ceases to be visible. It was, besides, observed that the one star disappears within a very short

distance from the sun, and that the other, when first seen after its periodical disappearance, is equally near to him on the opposite side. The distance which each recedes from the sun was likewise remarked to be the same; and the times during which they are alternately visible were found to be equal. These phenomena led some bolder genius to affirm that Hesperus and Lucifer are the same star, which is alternately visible in the morning and evening, according as it precedes or falls behind the sun. Obvious as this conclusion is, it was not arrived at till after many ages of reflection and experience.

Since Venus never appears at a greater distance from the sun than about 47° , it is evident that the earth is neither the centre of her orbit, nor included within it; for in either case she would sometimes, like the moon, be seen in opposition to the sun. From the appearances which have as yet been described, it can only be inferred that Venus is a satellite of the sun, and that her orbit is carried along with him in his annual revolution in the ecliptic; but the phenomena which she presents when seen through the telescope afford the means of deducing more definite conclusions.

When Venus, after having been for some time visible in the evening, begins to approach the sun, she appears through the telescope as a fine luminous crescent, the horns of which are turned towards the east, and which becomes narrower as her distance from the sun diminishes. After she has passed the sun, and begins to appear in the morning, the horns of the crescent are turned towards the west, and its breadth gradually enlarges in proportion as the planet recedes from the sun, till she has gained her greatest elongation, when her disk becomes a semicircle. After this she begins to approach the sun with an accelerated motion, and her disk becomes gibbous, the illuminated or visible part being greater than a semicircle; and when she overtakes the sun, her disk has attained the dimensions of a full orb. Having passed the sun, the orb begins again to contract, and passes through the same gradation of changes on the eastern side of the sun, till the planet comes again into conjunction, when it vanishes entirely. All these phases, which nearly resemble those of the moon, are illustrated by fig. 56. When Venus is in the superior conjunction at A, or in the same straight line with the sun, she presents the full orb, because the hemisphere enlightened by the sun is turned directly towards the earth at E. Arrived at B, the illuminated hemisphere is not turned exactly towards the earth, and consequently one side of her orb must appear elliptical, the major axis being to the minor as radius to the cosine of the inclination of the planes of illumination and vision, as was shown in explaining the phases of the moon. (Chap. iii. sect. 1.) At C, where the straight lines drawn from the planet to the earth and sun form a right angle, the minor axis of the ellipse vanishes, and we have the half-illuminated orb. At D only a small portion of the enlightened hemisphere is visible from E; and when the planet arrives at F, the inferior conjunction, her dark side is wholly turned towards the earth, and she is invisible.

Mercury exhibits phenomena exactly analogous to those of Venus. Like Venus, he oscillates on opposite sides of the sun; but his oscillations are much quicker, and performed in a much smaller arc. His greatest elongation or distance from the sun does not exceed $28^\circ 20'$; so that he never appears above the horizon longer than an hour and 50 minutes after sunset or before sunrise. He emits a very vivid white light; but, by reason of his proximity to the sun, he is seldom visible to the naked eye. His phases resemble those of Venus, and he is frequently seen as a dark spot passing over the sun's disk.

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From these phenomena several important conclusions may be drawn. In the first place, Mercury and Venus are opaque bodies, which are only visible in consequence of the sun's rays reflected from their surfaces. In the second place, their orbits are described about the sun, and do not embrace the earth, because both planets pass between the sun and the earth, and their digression from the sun never exceeds a certain limit. For this reason they are called *Inferior Planets*. In the third place, since the digressions of Venus are much more considerable than those of Mercury, it is obvious that her orbit includes that of Mercury. This last fact is established by other phenomena. Their angular velocities may be compared by means of the times which they respectively employ in returning to their conjunctions; and in this way it is found that the angular velocity of Mercury is nearly three times greater than that of Venus—a circumstance of itself sufficiently indicative of his greater proximity to the sun. But the occultation of one of these planets by the other furnishes a decisive evidence of the disposition of their orbits. On the 17th of May 1737 Mercury was observed to be eclipsed by Venus near their inferior conjunction; whence it follows that Venus is nearer the earth, and consequently at a greater distance from the sun. This fact was known to the Egyptians, and the name of the *Egyptian System* given to that theory according to which Mercury and Venus were regarded as satellites of the sun; but as the ancient astronomers were unacquainted with one of its strongest proofs, namely, the transits, and could only form inferences from the digressions, it was not generally adopted by them.

The revolution of Venus and Mercury about the sun may also be inferred from the variations of their apparent diameters, although, on account of the unequal distances of the sun from the earth, these variations are subject to considerable irregularities. When Venus approaches nearest to the earth, her apparent diameter subtends an angle of about $61''$, while it does not amount to $10''$ when she is at her greatest distance. The apparent diameter of Mercury varies from $12''$ to $5''$, indicating corresponding variations of distance. These variations of his apparent diameter are not sensible to the naked eye, on account of the irradiation which surrounds the disks of the planets, and which renders it impossible to form any correct judgment respecting the magnitudes of small luminous objects seen from so great a distance.

The phenomena of the other planets differ in some respects from those of Mercury and Venus. Instead of remaining constantly within a certain distance from the sun, their angles of elongation assume all possible values, and they are frequently seen in opposition, and consequently more distant from him than the earth is. Their orbits, therefore, embrace the earth; and as they are never observed in their conjunctions to pass, like the inferior planets, over the sun's disk, even when the direction of their motion traverses the sun, it follows that the sun is also included within their orbits. This fact is rendered certain by the appearance of their disks at the time when they are in conjunction. If they were then placed between the sun and the earth, their disks would appear cornicular, like those of Mercury and Venus; but they uniformly present a full orb at the time of their conjunction, and consequently the same hemisphere is presented to the earth and the sun, at least if, as is certain, they derive their light from him. They must therefore be situated beyond the sun. From the circumstance that their orbits include both the earth and the sun, they are called *Superior Planets*. In order to determine whether the sun or the earth is the centre of their motions, it will be con-

venient to have recourse to observations of their apparent diameters, which, if their orbits are circular, and have the earth in their centre, will always be of the same magnitude. But the apparent diameter of Mars gradually increases from his conjunction to his opposition; and therefore, since the distance of the planet is directly proportional to the magnitude of its apparent diameter, Mars is nearer to the earth at his opposition than at his conjunction. The variations of the apparent diameter of this planet are very considerable, the limits being $18''.28$ and $3''.6$; so that Mars is five times farther from the earth at his greatest distance than at his least. His orbit, therefore, cannot be a circle described about the earth. We might indeed suppose it to be an ellipse, or other elongated curve; but the enormous eccentricity which it would be necessary to assign to it renders this supposition extremely improbable. The analogy of Venus and Mercury will rather lead us to infer that the sun is the centre of his motion; and of this we have a geometrical proof in the circumstance that the difference of his greatest and least distances is equal to the diameter of the earth's orbit. Jupiter, Saturn, and Uranus, present exactly similar phenomena. We therefore conclude in the same manner that they are superior planets, circulating about the sun.

The order of distance in which the superior planets are disposed about the sun and the earth may be inferred either from the rate of their motion when they are in opposition with the sun (it being natural to suppose that their velocities will diminish in proportion to their distances or the magnitude of the orbit which they describe), or it may be determined from the variation of their apparent diameters. Now, the apparent diameters at the conjunctions and oppositions are nearly in the following ratio: those of Mars as 1 to 5, of Jupiter as 10 to 15, of Saturn as 1 to 1.23 ; hence the diameter of the terrestrial orbit is to the diameters of the orbits of Mars, Jupiter, and Saturn, as the difference of the preceding numbers is to their sum, or as unity to the numbers $1\frac{1}{2}$, 5, and $9\frac{1}{2}$. In this manner we find that Jupiter is at a much greater distance from the earth than Mars, and Saturn than Jupiter.

It has already been remarked that the apparent motions of the planets are not always in the same direction. Through the most considerable part of their orbits they move from west to east, according to the order of the signs; and their motion is most rapid when they are at the greatest distance from the earth. It gradually relaxes until the planet has reached its greatest eastern digression if it is an inferior planet, or its eastern quadrature if a superior one; after which its proper motion is slower than the sun's motion in the ecliptic. In the course of a short time the planet seems stationary among the stars for some days, its right ascension undergoing scarcely any variation. In the course of a few days more, however, it begins again sensibly to change its place, and now moves in an opposite direction, or retrogrades. This retrograde motion continues to be accelerated as the planet approaches its inferior conjunction, or its opposition, at which point it attains its maximum. After this it begins to be retarded; the planet becomes a second time stationary, and then assumes its direct motion, to pass through another series of similar changes. The arc and time of retrogradation are different for each of the planets, being greatest in the case of those which are nearest the earth, and least for those which are at the greatest distance.

These phenomena, which are called the *Stations* and *Retrogradations* of the planets, were observed with great attention by the ancients and the astronomers of the middle ages, to whom their explanation gave much embarrassment on account of their being incompatible with

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Theoretical Astronomy. motions. In fact, if the earth is supposed immovable, the path described by the planets is a curve so extremely complicated and irregular, that Aristotle, and even Riccioli, who lived in an age when the celestial motions were much better known, were reduced to the necessity of supposing a genius or angel to reside in each of the planets, directing its motions as the mind of man directs the motions of his body. Suppose the earth to be at rest in E (fig. 57), the orbit of a superior planet will resemble the curve *abcdef*, &c. When the planet arrives at *b*, before it comes into opposition with the sun at A it becomes stationary. From *b* to *c* it retrogrades, and is again stationary at *c*. Its motion then becomes direct, and its distance from the earth continues to increase while it runs through the arc *defgh*, and till it arrives at *h*, and is in conjunction with the sun at B. It is then at its greatest distance, and in passing through the arc *klm* continues to approach the earth till it arrives at *m*, in opposition with the sun at C. Here it exhibits the same phenomena as at the former opposition, becoming stationary, retrograding, &c.; and at every succeeding opposition describes a sort of node or loop, similar to *lmn*. Its path is thus made up of an infinity of nodes, and presents a sufficiently striking resemblance to an epicycloid. Fig. 58, which has been copied from Cassini into most of the elementary treatises of astronomy, represents the apparent motions of Saturn, Jupiter, and Mars, in respect of the earth.

Plate
LXXXIV
Fig. 57.

System of
epicycles.

Plate
LXXXV
Fig. 59.

Such are the general phenomena presented by the motions of the planets. We must next endeavour to determine the nature of the curve described by each of them, and the law according to which it is described, in order to arrive at the solution of the principal problem of astronomy, viz. to express the position of the heavenly bodies in terms of the time reckoned from a given instant.

The first successful attempt to frame a system by means of which the motions of the planets might be numerically calculated, was made by Apollonius of Perga. Apollonius supposed that a planet, instead of describing a circle about the earth, moves in the circumference of a second circle, the centre of which is carried round the circumference of the first. Let us suppose two unequal circles, situated in the same plane, the greater of which ACB (fig. 59), which is called the *deferent*, carries on its circumference the centre of the smaller PRP'S, which is called the *epicycle*; and let us also suppose that each of these circles turns uniformly about its centre, according to the order of the signs, that is, from west to east. The earth is situated at E the centre of the deferent, and the planet whose motions we consider is placed on the circumference of the epicycle. The phenomena resulting from this disposition will be different according to the ratio of the velocities of the two circles. In the first place, suppose the velocities to be equal, and that at the first instant the planet is placed at P, the extremity of the straight line which joins the centres of the deferent and epicycle: the planet is then at its apogee, and it is evident that its apparent velocity is the greatest possible, being the sum of the velocities in the two circles. It is evident also that the apparent velocity of the planet will diminish as it approaches the lower extremity P' of its epicycle, or its perigee, and that in this point it will vanish altogether, because the perigee is carried backwards in the direction RP'S by the motion of the epicycle with a velocity equal to that by which it is carried forward by the motion of the deferent. From this point the apparent motion will receive a gradual augmentation of velocity, till the planet arrives again at its apogee, where it will recommence a course perfectly similar to the preceding. In this case, therefore, the

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Let us next suppose that the velocity of the epicycle is greater than that of the deferent, which is the hypothesis adopted by Apollonius and Ptolemy. From P to R the motion of the planet is direct. At the point R its path coincides with the tangent RE, and it would be stationary if the epicycle were immovable; but as the epicycle advances according to the order of the signs, the planet will continue to move directly till it arrives at the point π , where its retrograde motion in the epicycle, in the direction $\pi P'$, is equal to the direct motion in the deferent. At the perigee P' the planet will retrograde, because the directions of the two motions are diametrically opposite, and the retrograde motion in the epicycle is greater than the direct motion in the deferent. At π it becomes a second time stationary, after which it resumes its direct motion, precisely according to the actual phenomena.

Lastly, if we suppose the velocity of the deferent to be Ptolemaic greater than that of the epicycle, there will be neither station nor retrogradation, and the planet will always advance in the same direction, but contrary to that of the motion of the deferent. This, in the Copernican system, would be the motion of the moon with reference to a spectator placed on the sun, and regarding the orbit of the earth about the sun as the deferent, and that of the moon about the earth as the epicycle; for then the velocity of the earth about the sun would be about thirty times greater than that of the moon about the earth.

This method of representing the geocentric motions of the planets was adopted and fully developed by Ptolemy, who assigned the ratios of the radii of the epicycles and deferents of each of the planets, and disposed the orbits in the manner most conformable to the apparent motions. It may be remarked that the absolute lengths of the radii are immaterial; it is only their relative lengths to which it is necessary to have regard. As observations were multiplied, and new inequalities in the motions of the planets detected, the system of simple epicycles was in most instances found insufficient to explain the phenomena. Double and triple systems were therefore introduced, in which the first epicycle was regarded as a second deferent carrying its own epicycle, the second epicycle as a third deferent, and so on, till every irregularity of motion was explained. It is easy to conceive all this mechanism, and even to reduce it to general formulæ; but although it affords considerable facility for calculation, it is much too complicated to have place in nature. It is now well known that the orbits of the planets are not epicycloids, but ellipses: nevertheless, at a time when the circle and straight line alone were admitted in the solution of geometrical problems, it was extremely natural to inquire whether any construction could be found, without employing other curves, to represent the planetary motions; and the system of epicycles which resulted from this inquiry will remain a perpetual monument of the ingenuity of its authors, Apollonius and Ptolemy.

In arranging the planetary system, Ptolemy placed the earth at the centre of the universe, and nearest to it the moon, whose synodic revolution is the shortest of all, being performed in $29\frac{1}{2}$ days. Next to the moon he placed Mercury, who returns to his conjunctions in 116 days. After Mercury followed Venus, whose periodic time is 584 days. Beyond Venus he placed the sun, then Mars, next Jupiter, and lastly Saturn, beyond which is the sphere of the fixed stars. (See fig. 60.) Plato and some other philosophers had placed the orbit of the sun immediately after that of the moon, and Mercury and Venus beyond the sun, on account that these planets

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Theoretical Astronomy. were never seen on the solar disk. Ptolemy, however, remarked that this reason was inconclusive, because the planets might easily be supposed to pass between the sun and the earth, without appearing exactly on the sun's disk, in the same manner as the new moons do not always cause a solar eclipse. In the system of Ptolemy, it is, however, a matter of absolute indifference whether the orbits of these planets are placed above or below that of the sun, inasmuch as the phenomena are exactly the same in both dispositions. This fact doubtless furnishes a strong objection to his system, and might have led him, we are apt to suppose, to adopt the system of the ancient Egyptians with regard to Mercury and Venus, and place the sun at the common centre of their orbits. But it must be recollected that Ptolemy had no means of measuring the diameters of the planets, or of forming any accurate notions of their distances; he was unacquainted with the phases of Venus, which demonstrate the revolution of that planet about the sun; and, in short, knew of no phenomenon which could not be reconciled with his system. His object was solely to represent the apparent motions by a geometrical construction, and by such means as geometry at that time could legitimately employ; and this object he fully accomplished. He never regarded his system in any other light than as a mere hypothesis, by means of which the celestial phenomena could be reduced to calculation.

System of Copernicus. But while thus much must be conceded in favour of the system of Ptolemy, it must be confessed that scarcely any thing could well be imagined more complicated and cumbersome; more at variance with the simplicity which pervades the economy of nature, or, in a physical point of view, more absurd. Yet so prone is the human mind to cling to the ideas which have been first presented to it, and with so much difficulty are errors which have once obtained a firm footing eradicated, that, till the beginning of the 16th century, it was implicitly followed by astronomers of all countries. The glory of bursting the fetters of prejudice and authority, and of building the true system of the world on the ruins of a fabric which had been erected with so much address and labour, was reserved for Copernicus. This great man was led, by a profound meditation on the different hypotheses which had been imagined to account for the apparent motions of the heavenly bodies, to adopt the ideas of some of the ancients, and remove the earth from the centre of the world, ascribing to it a double motion of rotation about its own axis and of revolution about the sun. From some scattered hints contained in the writings of the ancient philosophers, Copernicus composed the system which retains his name; a system of the truth of which the complete development of the planetary theory has furnished the most convincing and satisfactory proofs. According to this system the sun is the common centre of the orbits of all the planets, which revolve around him in the following order:—Mercury, Venus, the Earth, Mars, Jupiter, and Saturn. Far beyond the orbit of Saturn he supposed the fixed stars to be placed, which formed the boundaries of the visible creation.

Tychonic system. Although the great simplicity and beauty of the Copernican system soon recommended it to the adoption of the most philosophical of the astronomers of that period, yet for a long time it met with considerable opposition. The most eminent of its opponents was the celebrated Tycho Brahe, who could never bring himself to adopt the supposition of the motion of the earth. The principal objections which he urged against it were the immense distance at which it is necessary to suppose the fixed stars to be placed, in order to account for the smallness, or rather

Theoretical Astronomy. the entire absence, of the annual parallax; the improbability that a heavy mass like the earth should have so rapid a motion; and some passages of Scripture which seem to suppose the motion of the sun and the immobility of the earth. Tycho, therefore, proposed another system, in which he endeavoured to retain the most essential advantages of the Copernican theory, and at the same time preserve the earth's stability. In the system of Tycho the earth is supposed to be the centre of the solar and lunar orbits, and the sun to be the centre of all the planetary orbits, the orbits of the two inferior planets being smaller, and those of the superior larger, than the orbit of the sun; a distinction which is necessary for the explanation of the conjunctions and oppositions. This disposition of the orbits will be understood by referring to fig. 61. The system of Tycho is far less philosophical than that of Copernicus, and he has therefore exposed himself to the charge of having made a retrograde movement in science; but it must be confessed that it affords a satisfactory explanation of all the phenomena, and that the objections which can be urged against it are not of an astronomical, but of a physical or mechanical nature. In fact, if the planets are supposed to revolve about the sun, it is absolutely indifferent, so far as regards the phenomena, whether the annual motion is ascribed to the sun or the earth; but it is a physical absurdity to suppose that the sun, with its whole train of attendant planets, revolves about the earth, which, in comparison of them, is a mere atom.

Effects of the earth's motion on the appearances of the planets. Taking the truth of the Copernican theory for granted, let us consider what effect the motion of the earth has upon the apparent motions of the other planets. Were the earth to stand still in any part of its orbit, the places of conjunction both in the superior and inferior semicircle, as also of the greatest elongation, and consequently the places of direct and retrograde motion, and of the stations of an inferior planet, would always be in the same part of the heavens; whereas, on account of the earth's motion, the places where these appearances happen are continually advancing forward in the ecliptic, according to the order of the signs. In fig. 62 let ABCD be the orbit of the earth; *efgh* that of Mercury; ☉ the sun; GFKI an arc of the ecliptic extended to the fixed stars. When the earth is at A, the sun's geocentric place is at F; and Mercury, in order to be in conjunction, must be in the line AF; that is, in his orbit he must be at *f* or *h*. Suppose him to be at *f* in his inferior semicircle: if the earth stood still at A, his next conjunction would be when he is in his superior semicircle at *h*; the places of his greatest elongation also would be at *e* and *g*, and in the ecliptic at E and G. But supposing the earth to go on in its orbit from A to B; the sun's geocentric place is now at K; and Mercury, in order to be in conjunction, ought to be in the line BK at *m*. As by the motion of the earth the places of Mercury's conjunctions are thus continually carried round in the ecliptic according to the order of the signs, so the places of his greatest elongations must also be carried forward in the same direction. Thus, when the earth is at A, the places of his greatest elongation from the sun are in the ecliptic E and G; the motion of the earth from A to B advances them forward from G to L and from E to I. But the geocentric motion of Mercury will best be seen in fig. 63. Here we have part of the extended ecliptic marked φ , γ , π , &c., in the centre of which S represents the sun, and round him are the orbits of Mercury and the Earth. The orbit of Mercury is divided into 11 equal parts, such as he goes through once in eight days; and the divisions are marked by numeral figures, 1, 2, 3, &c. Part of the orbit of the earth is like-

Theoretical Astronomy. wise divided into 22 equal arcs, each arc being as much as the earth goes through in eight days. The points of division are marked with the letters *a, b, c, d, e, f, &c.* and show as many several stations from whence Mercury may be viewed from the earth. Suppose then the planet to be at 1 and the earth at *a*; draw a line from *a* to 1, and it shows Mercury's geocentric place at A. In eight days he will have advanced to 2, and the earth to *b*; draw a line from 2 to *b*, and it shows his geocentric place at B. In other eight days he will have proceeded to 3, and the earth to *c*; a line drawn from 3 to *c* will show his geocentric place at C. In this manner, going through the figure, and drawing lines from the earth at *d, e, f, g, &c.* through 4, 5, 6, 7, &c. we shall find his geocentric places successively at the points D, E, F, G, &c. where we may observe, that from A to B, and from B to C, the motion is direct; from C to D, and from D to E, retrograde. In this figure 22 stations are marked in the earth's orbit from whence the planet may be viewed, corresponding to which there ought to be as many in the orbit of Mercury; but as the periodic time of that planet does not include so many intervals of eight days, his place is marked at the end of every eight days for two of his periodical revolutions; and to denote this, two numeral figures are placed at each division.

The geocentric motion of Venus may be explained in a similar manner; only, as the motion of Venus is much slower than that of Mercury, her conjunctions, oppositions, elongations, and stations, all return much less frequently than those of Mercury.

Plate
LXXXV.

To explain the stationary appearances of the planets, it must be remembered, that the diameter of the earth's orbit, and even that of Saturn, are but mere points in comparison of the distance of the fixed stars; and therefore any two lines, though absolutely parallel, drawn at the distance of the diameter of Saturn's orbit from each other, would, if continued to the fixed stars, appear to us, to terminate in the same point. Let, then, the two circles fig. 64 represent the orbits of Venus and of the Earth; let the lines AE, BF, CG, DH, be parallel to SP, we may nevertheless affirm, that if continued to the distance of the fixed stars, they would all terminate in the same point with the line SP. Suppose, then, Venus at E while the earth is at A, the visual ray by which she is seen is the line AE. Suppose again, that while Venus goes from E to F, the earth goes from A to B, the visual ray by which Venus is now seen is BF parallel to AE; and therefore Venus will be all that time stationary, appearing in that point of the heaven where SP, if extended, would terminate: this station is at her changing from direct to retrograde. Again, suppose, when the earth is at C, Venus is at G, and the visual line CG; if, while the earth goes from C to D, Venus goes from G to H, so that she is seen in the line DH parallel to CG, she will be all that time stationary, appearing in the point of the celestial sphere determined by the prolongation of SP. This station is at her changing from retrograde to direct; and both are in her inferior semicircle.

As the superior planets move in larger orbits than the earth, they can only be in conjunction with the sun when they are on the side opposite to the earth; as, on the other hand, they are in opposition to him when the earth is between the sun and them. They are in quadrature when their geocentric places are 90° distant from that of the sun. In order to understand their apparent motions, we shall suppose them to stand still in some part of their orbit while the earth makes a complete revolution; in which case any superior planet would have the following appearances:—1. While the earth is in its

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The direct motion of a superior planet is more rapid the nearer it is to a conjunction, and slower as it approaches to a quadrature with the sun. Thus, in fig. 66, let ☉ be the sun, the little circle round it the orbit of the earth, of which *abcdefg* is the most distant semicircle, OPQ an arc of the orbit of Jupiter, and ABCDEFG an arc of the ecliptic in the sphere of the fixed stars. If we suppose Jupiter to stand still at P, by the earth's motion from *a* to *g* he would appear to move directly from A to G, describing the unequal arcs AB, BC, CD, DE, EF, FG, in equal times. When the earth is at *d*, Jupiter is in conjunction with the sun at D, and there his direct motion is swiftest. When the earth is in that part of its orbit where a line drawn from Jupiter would touch it, as in the points *e* or *g*, Jupiter is nearly in quadrature with the sun; and the nearer the earth is to any of these points, the slower is the geocentric motion of Jupiter; for the arcs CD and DE are greater than BC or EF, and the arcs BC and EF are greater than AB or FG.

The retrograde motion of a superior planet is more rapid the nearer it is to an opposition, and slower as it approaches to a quadrature with the sun. Thus, let ☉, fig. 67, be the sun, the little circle round it the orbit of the earth, whereof *ghiklmn* is the nearest semicircle, OPQ an arc of the orbit of Jupiter, NKG an arc of the ecliptic. If we suppose Jupiter to stand still at P, by the earth's motion from *g* to *n* he would appear to move from G to N, describing the unequal arcs GH, HI, IK, KL, LM, MN, in equal times. When the earth is at *k*, Jupiter appears at K in opposition with the sun, and there his retrograde motion is swiftest. When the earth is either at *g* or *n* (the points of contact of the tangents Pg and Pn), Jupiter is nearly in quadrature with the sun: and the nearer he is to either of these points the slower is his retrogradation; for the arcs IK and KL are greater than HI or LM, and the arcs HI and LM are greater than GH

Theoretical Astronomy. Plate LXXXV. Plate LXXXVI. MN. Since the direct motion is swiftest when the earth is at *d* (fig. 66), and continues diminishing till it changes to retrograde, it must be insensible near the time of change; and, in like manner, the retrograde motion being swiftest when the earth is in *k* (fig. 67), and diminishing gradually till it changes to direct, must also at the time of that change be insensible; for any motion gradually decreasing till it changes into a contrary one gradually increasing, must at the time of the change be altogether insensible.

The same changes in the apparent motions of this planet will also take place if we suppose him to advance slowly in his orbit; only they will happen successively when the earth is in different parts of its orbit, and consequently at different times of the year. Thus (fig. 65), let us suppose that while the earth goes round its orbit, Jupiter goes from *F* to *G*; the points of the earth's orbit from which Jupiter will now appear to be stationary will be *x* and *y*; and consequently his stations must be at a time of the year different from the former. Moreover, the conjunction of Jupiter with the sun will now be when the earth is at *f*, and his opposition when it is at *e*; for which reason these also will happen at times of the year different from those of the preceding opposition and conjunction. The motion of Saturn is so slow, that it occasions but little alteration either in the times or places of his conjunction or opposition; and the same will take place in a more eminent degree in Uranus; but the motion of Mars is so much swifter even than that of Jupiter, that both the times and places of his conjunctions and oppositions are thereby very much altered.

Fig. 68 exemplifies the geocentric motion of Jupiter in a very intelligible manner. In this figure ☉ represents the sun; the circle 1, 2, 3, 4, the orbit of the earth, divided into twelve equal arcs for the twelve months of the year; PQ an arc of the orbit of Jupiter, equal to that which he describes in a year, and divided in like manner into twelve equal parts, each representing the arc he describes in a month. Now suppose the earth to be at 1 when Jupiter is at *a*, a line drawn through 1 and *a* shows Jupiter's place in the celestial ecliptic to be at *A*. In a month's time the earth will have moved from 1 to 2, Jupiter from *a* to *b*; and a line drawn from 2 to *b* will show his geocentric place to be in *B*. In another month the earth will be in 3, and Jupiter at *c*, and consequently his geocentric place will be at *C*; and in like manner his place may be found for the other months at *D*, *E*, *F*, &c. It is likewise easy to observe that his geocentric motion is direct in the arcs AB, BC, CD, DE; retrograde in EF, FG, GH, HI; and direct again in IK, KL, LM, MN. The inequality of his geocentric motion is likewise apparent from the figure.

Supposing the orbits of the planets to be circular, the points of station, and the extent and duration of the retrogradations, may be geometrically determined with great facility; but if we attempt to take into consideration all the inequalities of the orbits, the problem becomes one of extreme complication and difficulty. This, however, is the less to be regretted, on account that it is more a problem of curiosity than of any real importance, and the mean values which result from the supposition of circular orbits are more than sufficiently accurate for all the uses which are now made of these phenomena.

Let *S*, fig. 69, be the sun, *E* and *V* two planets (which we may suppose to be the Earth and Venus) revolving in their respective orbits in the times *T* and *t*: the problem is, to determine those points at which one of them, as seen from the other, will become stationary, and the extent of the arc through which it will appear to retrograde. Suppose the spectator to be placed at *E*, and *V* to be the

Theoretical Astronomy. point at which Venus is stationary. Also let the semidiameters of their orbits *SE* and *SV* be *R* and *r* respectively, the angle of digression *SEV* = ϕ , and the angle *SVE* = ψ . During a short time, at the station, the lines *EV* and *ev* (*Ee* and *Vv* being very small arcs) may be considered as parallel; therefore $\phi = Suv = Sev + ESe = \phi + \delta\phi + ESe$, whence $\delta\phi = -ESe$. In like manner $\psi = Sxe = Sve - VSv = \psi + \delta\psi - VSv$; whence $\delta\psi = VSv$. But as the orbits are described uniformly, $T : t :: VSv : ESe$, and consequently $T : t :: \delta\psi : \delta\phi$. Now, the triangle *SEV* gives the equation

$\sin. \psi = \frac{R}{r} \sin. \phi$, from which, by differentiating, we get

$\delta\psi \cos. \psi = \frac{R}{r} \delta\phi \cos. \phi$, and consequently $\delta\psi : \delta\phi ::$

$R \cos. \phi : r \cos. \psi$. Comparing this with the above proportion, we have $T : t :: R \cos. \phi : r \cos. \psi$, whence $r \cos. \psi$

$= \frac{t}{T} R \cos. \phi$. Taking the squares, and adding $r^2 \sin.^2 \psi$ $= R^2 \sin.^2 \phi$, there results

$$r^2 T^2 = R^2 (t^2 \cos.^2 \phi + T^2 \sin.^2 \phi),$$

whence we derive

$$\sin. \phi = \frac{1}{R} \left(\frac{r^2 T^2 - R^2 t^2}{T^2 - t^2} \right)^{\frac{1}{2}};$$

or, if we suppose $\frac{r}{R} = r'$, and $\frac{t}{T} = t'$,

$$\sin. \phi = \left\{ \frac{(r' + t')(r' - t')}{(1 + t')(1 - t')} \right\}^{\frac{1}{2}}.$$

From this formula, all the circumstances connected with the stations and retrogradations are easily computed, when the diameter of the orbit and the periodic time of the planet are known. Thus, relatively to Venus, the quantity r' , that is, the ratio of the diameter of her orbit to that of the earth, is, as will be shown in next section, equal to 0.723, and

$t' = \frac{224.7}{365.25} = 0.6152$, whence $\sin. \phi = \sqrt{\frac{1.338 \times 108}{1.615 \times 385}} = 0.48208$; and $\phi = 28^\circ 49'$. The angle ψ is obtained from the equation $\sin. \psi = \frac{\sin. \phi}{r'}$, which gives $\psi = 138^\circ 11'$.

The angle *VSE* at the sun, or the heliocentric distance of Venus and the Earth, which we shall designate by χ , is $180^\circ - (\phi + \psi) = 13^\circ$. From this angle we likewise obtain the time from the station to the conjunction; for since the mean daily motion of Venus is $1^\circ 36' 7'' 8$, and that of the earth $59' 8'' 3$, the relative daily motion is $36' 59'' 5$,

therefore the time from conjunction will be $\frac{13^\circ}{36' 59'' 5}$, or about 21 days, and consequently the retrograde motion of Venus will continue about 42 days.

If in the equation $\sin. \phi = \frac{1}{R} \left(\frac{r^2 T^2 - R^2 t^2}{T^2 - t^2} \right)$ we suppose $rT = Rt$, the angle ϕ vanishes; consequently there will be no regression, and the station will only be momentary at the inferior conjunction. In this case $r : R :: t : T$, or the distances of the planets are proportional to their periodic times. If Rt were greater than rT , ϕ would become imaginary, and the motion of the planet would always be direct. The stations and retrogradations are therefore consequences of that law of the system according to which the distances are to one another in a greater ratio than the periodic times.

The following table, given by Delambre (*Astronomie*, tome iii. p. 9), exhibits the elements of the stations and retrogradations of the planets, calculated from formulæ equivalent to the above.

	Mercury.	Venus.	Mars.	Ceres.	Jupiter.	Saturn.	Uranus.
ϕ	18° 12'	28° 51'	136° 12'	126° 7'	115° 35'	108° 47'	103° 15'
ψ	126 14	138 9	27 1	18 6	9 59	5 42	2 55
χ	35 34	13 0	16 47	35 47	54 26	65 31	73 52
Mean Arc	13° 24'	15° 22'	14° 41'	10° 30'	9° 55'	6° 47'	3° 45'
Limits	9°...16°	14°...17°	10°...20°		9°·8...10°	6°·7...6°·9	3°½...4°
Duration	22 ^d ·9	42 ^d ·16	72 ^d ·76	97 ^d ·45	120 ^d ·7	137 ^d ·6	151 ^d ·7
Limits	21½...23½	41...43½	61...81½		117...122½	135...139	150...153

SECT. II.—Of the Orbits of the Planets.

In determining the elements of the orbits of the sun and moon, the labour of the astronomer is facilitated by the circumstance that the earth, at which his observations are made, either is, or may be regarded as, the centre of motion. But in the case of the planets, the sun, and not the earth, is situated in the centre of their orbits, and consequently the elements of those orbits must be determined from the measurement of certain linear and angular distances from the sun: it is therefore necessary, as a preliminary step, to convert the geocentric into heliocentric observations, that is, to deduce the true place of a planet as seen from the sun, from its apparent place as seen from the earth. On this account the determination of the planetary orbits is attended with somewhat greater difficulties than those which present themselves in the cases of the sun and moon.

1. *Nodes and Inclinations of the Planetary Orbits.*—Conformably with the plan which has been followed in the two preceding chapters, we will first consider those elements which determine the position of the plane of the orbit of a planet; and then those which regard the orbit itself, that is to say, the elements and position of the ellipse which the planet describes. When these are known, and the astronomer is also acquainted with the mean motion, or the time of the periodic revolution of the planet, and the instant at which it occupied any given point of its orbit, he is in a condition to assign the epoch at which it will again occupy the same or any other given point; and this comprehends the complete solution of the problem which he proposes to himself. It is proper, however, to remark here, that although this method of considering the elements separately is extremely convenient, perhaps indispensable, for the purpose of illustration, it is neither that which the practical astronomer follows, nor that by which the various truths which compose the actual system of theoretical astronomy were discovered. No discovery in astronomy has perhaps ever been made by a direct process. The elements first obtained from the observations are imperfect and inexact, and it is only by successive and frequently laborious approximations that they are advanced to accuracy. Hypotheses are first framed to account for or classify the phenomena; the results of these arbitrary suppositions are computed and compared with new observations; and the differences which are found to exist between the computed and observed quantities serve to verify or correct the assumption, or suggest other approximations still nearer the truth. In astronomy, as Woodhouse remarks, scarcely one element is presented simple and unmixed with others. Its value, when first disengaged, must partake of the uncertainty to which the other elements are subject, and can be supposed to be settled to a tolerable degree of exactness only after multiplied observations and many revisions. There are no simple theorems for determining at once

the parallax of the sun, or the heliocentric latitude of a planet.

To give a general idea of the method of reducing geocentric to heliocentric longitudes and latitudes, let S (fig. 70) be the sun, E the earth, P the place of a planet in its orbit NP, NA the ecliptic, and N the ascending node, or that point of the ecliptic through which the planet passes when it comes to the north of that plane. Let S φ , E φ , be drawn from S and E to the first point of Aries; and because the parallax of the fixed stars is insensible, their distance being infinitely great in comparison of the distance of the earth from the sun, S φ and E φ are considered as parallel to one another. Let also PL be drawn perpendicular to the ecliptic, and the other lines as in the figure. It is easy to see that as NPC, NLA are regarded as the intersections of the planes of the orbits of the earth and the planet with the celestial sphere, the centre of which is occupied by the sun, they are portions of great circles; and consequently every question relative to the position of the planet may be resolved by the formulæ of spherical trigonometry. In fact, PL being a circle of latitude, the arc φ NL is the *Heliocentric Longitude* of the planet, φ N the longitude of the ascending node, and the spherical angle PNL the inclination of the orbit. In order that the longitude of the planet in its orbit may not differ greatly from its longitude referred to the ecliptic, the former is not reckoned from the node N, but from another point equally distant from the node with the vernal point φ ; so that the longitude of the planet is obtained by adding NP to the longitude of the node. The latitude also depends immediately on the distance NP of the planet from the ascending node; hence NP is called the *Argument of the Latitude*; and the difference between the longitudes in the orbit and ecliptic, that is, NP—NL, is called the *Reduction to the Ecliptic*. The angle PEL, or the planet's apparent distance from the ecliptic to an observer at E, is the *Geocentric Latitude*; PSL, its distance from the ecliptic when viewed from the sun, is its *Heliocentric Latitude*. It is evident from the mere inspection of the diagram, that φ EL and φ SL are the geocentric and heliocentric longitudes respectively. The angles of the triangle ESL, from which the reductions are computed, being of very frequent use in practical astronomy, have received certain technical denominations with which it is convenient to be acquainted. The angle LES, which is the difference between φ EL and φ ES, the geocentric longitudes of the planet and the sun, is called the angle of *Elongation*; ESL, the angle at the sun, is called the angle of *Commutation*; and SLE, which is the difference between the heliocentric and geocentric longitudes, is called the *Annual Parallax*, or the *Prosthaphæresis of the Orbit*. In the case of an inferior planet, the annual parallax SLE may have any value between zero and 360°; but if the planet be a superior one, the greatest value of the annual parallax has place when the straight line drawn from the planet to the

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In order to determine the position of the orbit of a planet relatively to the ecliptic, it is necessary to discover in the first place the place of the nodes. The longitude of the node is the heliocentric longitude of the planet at the instant when it is in the ecliptic, and its geocentric and heliocentric latitudes are consequently both equal to zero. If then, at the same instant, the planet should happen to be in opposition with the sun, or (if an inferior one) in its inferior conjunction, its geocentric longitude, which is equal to the longitude of the sun $+ 180^\circ$, would be the heliocentric longitude of the node. But it can happen very rarely that the latitude of a planet is zero at the time of its opposition or conjunction, especially with regard to those of which the periodic times are considerable. Mercury and Venus, indeed, by passing oftener through their nodes within a given time, afford more chances of the occurrence of the phenomenon; and it does occur occasionally under very favourable circumstances when those planets pass over the disk of the sun, for at such times the latitude must be very small, that is, the planet must be very near its node. But this simple method of determining the heliocentric longitude of the node, although it may frequently be had recourse to in the case of Mercury, can seldom be practised with regard to Venus, and is of no use whatever in the cases of the other planets, because, on account of the greater length of their times of revolution, the oppositions and passages through the node take place simultaneously only after very long intervals.

Leaving, therefore, out of consideration the circumstance of opposition, let us inquire what other means are in our possession for determining the longitude of the node. It would be by an extraordinary chance that a planet should happen to be observed at the precise instant of its passage through its node; but if observed when very near it, the diurnal variations of latitude afford data for determining that instant by interpolation. Suppose, then, the planet to be in its node at N: the angle $\angle EN$ is obtained from observation, being the geocentric longitude of the node; and $\angle ES$, the longitude of the sun, is known from the solar tables. Hence, in the triangle ENS the angle $\angle SEN = \angle EN - \angle ES$ is known, as is also the side SE, which is the sun's distance from the earth. If, therefore, the angle at the planet, that is $\angle ENS$, can be found, every part of the triangle will be determined, and we shall then have the heliocentric longitude $\angle SN$ (equal to $180^\circ - \angle ENS + \angle ES$), and also the radius vector SN, or the distance of the planet from the sun. Now, the sides of a triangle being proportional to

the sines of their opposite angles, $\frac{SN}{SE} = \frac{\sin. \angle SEN}{\sin. \angle ENS}$

$= \frac{\sin. (\angle EN - \angle ES)}{\sin. (\angle SN - \angle EN)}$; but from this equation nothing can be deduced, inasmuch as it contains two unknown quantities, SN and $\angle SN$. Suppose, however, that the planet is observed a second time in its passage through the same node, and that the earth is then in another part of its orbit at e: this second observation will furnish another equation, viz. $\frac{SN}{Se} = \frac{\sin. \angle SeN}{\sin. \angle eNS} = \frac{\sin. (\angle eN - \angle eS)}{\sin. (\angle SN - \angle eN)}$, exact-

ly similar to the former, and in which Se is equal to SE. If, then, we suppose the place of the node has not sensibly changed in the interval between the two observations, this last equation will furnish a second relation between the two unknown quantities SN and $\angle SN$, by com-

binning which with the former, the values of both those quantities may be determined. By repeating the same observation, it will be seen whether the place of the node is fixed, or is subject to any other variation than that which arises from the precession of the equinoxes. Its variation, if it does vary, can only be determined by observations made at distant epochs.

When the longitude of the node has been determined in this manner, it will be easy to deduce the inclination of the orbit. For this purpose the planet may be observed at the time when the sun's longitude is equal to that of the node, and the earth is consequently situated in the line of the nodes. By this observation the elongation of the planet, which is then PEN (fig. 71), is given, as also its geocentric latitude PEL. Now, by reason of the right-angled triangles PEL and PSL, we have $PL = EL \tan. PEL = SL \tan. PSL$, consequently $\tan. PSL = \frac{EL}{SL} \tan. PEL$; but $EL : SL :: \sin. \angle LSN : \sin. \angle LES$,

therefore $\tan. PSL = \frac{\sin. \angle LSN}{\sin. \angle LES} \tan. PEL$. Now, by Na-

pier's rules for circular parts, the right-angled spherical triangle PNL gives also $\sin. \angle NL = \cot. \angle PNL \tan. PL$; whence $\tan. PL = \sin. \angle NL \tan. \angle PNL$; or, since $\tan. PL = \tan. PSL$, and $\sin. \angle NL = \sin. \angle LSN$, therefore $\tan. PSL = \sin. \angle LSN \tan. \angle PNL$. By equating these two values of $\tan. PSL$, we have

$$\sin. \angle LSN \tan. \angle PNL = \frac{\sin. \angle LSN}{\sin. \angle LES} \tan. PEL;$$

therefore, ultimately,

$$\tan. \angle PNL = \frac{\tan. PEL}{\sin. \angle LES};$$

that is, the inclination of the orbit is given in terms of the geocentric latitude and the longitude of the node.

The instant at which the sun is in the node of a planet's orbit cannot be easily seized; but the sun's mean motion being known, if his longitude is observed when it is nearly equal to that of the node, the time at which he passes through it may be determined with all the necessary accuracy by a simple proportion. It requires also to be remarked that the above method of determining the inclination takes it for granted that the position of the node is exactly known; but even should some uncertainty remain regarding this element, the resulting inclination would scarcely be affected in any sensible degree by a slight error, especially if at the time of the observation the planet is not very distant from its quadratures. In fact, if we make $\angle PNL = I$, $\angle PEL = \lambda$, and $\angle LES = \phi$, the above

equation becomes $\tan. I = \frac{\tan. \lambda}{\sin. \phi}$, which being differentiated

with respect to I and ϕ , gives $d \tan. I = - \frac{d\phi \cos. \phi \tan. \lambda}{\sin.^2 \phi}$.

But $d \tan. I = \frac{dI}{\cos.^2 I}$, and from the equation itself we

derive $\cos.^2 I = \frac{\sin.^2 \phi}{\sin.^2 \phi + \tan.^2 \lambda}$; therefore, by substituting

$$dI = - \frac{d\phi \cos. \phi \tan. \lambda}{\sin.^2 \phi + \tan.^2 \lambda}$$

From this it is evident that the error of inclination resulting from an erroneous position of the node will be smaller in proportion as ϕ is greater, and will disappear altogether when ϕ (that is, $\angle LES$ or the geocentric distance of the planet from its node) is 90° , that is to say, at the quadratures.

The process now explained for determining the position of the nodes gives at the same time the length of

Theoretical Astronomy. the radius vector SN; and, in consequence of certain relations which will be pointed out in the present section, all the other elements of the orbit may be deduced from simple observations of the passages of a planet through its nodes. But when approximate values of these elements are known, the heliocentric longitudes and latitudes may be found from geocentric observations of various kinds. If, therefore, the planet is observed several times before and after its passage through the node, the diurnal variations of longitude and latitude (which we at present suppose to be known very nearly) will give by interpolation the instant at which the latitude was nothing, and the heliocentric longitude, computed for that instant, will give the place of the node. By means of this more accurate determination the other elements may be corrected; and on repeating the same process with the corrected values, the longitude of the node will be obtained with still greater precision. These indirect methods of correcting the elements by one another were first employed by Kepler, and are of extensive application in every department of astronomy. They lead to more exact values of the elements of the planetary orbits than could be obtained from any direct method whatever.

As the passage of a planet through either of its nodes takes place only once during each periodic revolution, a remote planet, like Uranus, which moves very slowly, can very seldom be observed in those positions. Astronomers have therefore sedulously employed themselves in devising other methods by which all the elements of a planet's orbit may be discovered when a very small portion of it has been made known by observation. But these methods are the results of profound mathematical theory, based on the principle of Universal Gravitation, and could

not therefore be properly explained in this place. Their application belongs to Practical Astronomy. Theoretical Astronomy.

When the longitudes of the nodes of the planetary orbits are deduced by the methods explained above from ancient and modern observations, it is found that the nodes are not altogether fixed, but that, in respect of the fixed stars, they retrograde, or move from east to west; but their motion is so slow, that, although it is in reality, like every motion of the system, alternately accelerated and retarded, it may be regarded as uniform during a very long period of time. The inclinations of the orbits also undergo small variations, scarcely sensible to observation. The retrograde motion of the nodes of the planets, exactly analogous to that of the nodes of the moon, is a necessary consequence of the mutual gravitation of all the planetary bodies. The same is the case with the variations of inclination, of which the period and limits can only be calculated from the same theory to which we owe the knowledge of their existence. It is only indeed by the aid of the theories of Physical Astronomy that the greater part of these small secular variations can be disengaged from the periodic inequalities.

The following table exhibits the inclinations of the orbits of the planets, the positions of their nodes, and the variations of those elements. For the old planets the epoch is the commencement of the present century, that is to say, midnight preceding the 1st of January 1801. For Vesta, Juno, Ceres, and Pallas, the epoch is 1820. The annual increment of the longitude of the node is referred of course to the equinoctial point of Aries: to find its motion in respect of the fixed stars, it is only necessary to subtract the precession of the equinoxes, or 50".1, from the numbers given in the table.

Names.	Inclination.	Secular Variation of Inclination.	Longitude of Ascending Node.	Annual Variation of Longitude of Node.
Mercury.....	7° 0' 9".1	+ 18".1828	45° 57' 30".9	+ 42".3
Venus.....	3 23 28.5	— 4.5522	74 54 12.9	+ 32.5
Mars.....	1 51 6.2	— 0.1523	48 0 3.5	+ 26.8
Vesta.....	7 8 9.0		103 13 18.2	
Juno.....	13 4 9.7		171 7 40.4	
Ceres.....	10 37 26.2		80 41 24.0	
Pallas.....	34 34 55.0		172 39 26.8	
Jupiter.....	1 18 51.3	— 22.6087	98 26 18.9	+ 34.3
Saturn.....	2 29 35.7	— 15.5131	111 56 37.4	+ 30.7
Uranus.....	0 46 28.4	+ 3.1331	72 59 35.3	+ 14.2

2. *Of the Figures of the Orbits.*—After the position of the plane of a planet's orbit in space has been determined, it remains to trace its path on that plane, or to determine the figure and elements of the orbit itself. This, it is evident, may be accomplished, if we are in possession of the means of assigning, at any instant, the planet's distance from a fixed point in the plane of its orbit, and likewise the angle formed by the radius vector with a straight line given by position on the same plane. With these data a series of points may be laid down, representing the positions successively occupied by the planet; and the curve formed by joining them together will represent the orbit. Now, when the place of the nodes and the inclination are known, the radius vector and elongation may be computed by the rules of spherical trigonometry from a single observation of the planet's geocentric latitude and longitude at any epoch whatever; but by making the observations when the planet occupies certain situations of its orbit with respect to the earth, the difficulties attending the computation may be in a great measure eluded. If a planet, for example, is observed at the time

of its opposition or conjunction, there will be no occasion for a previous deduction of the heliocentric from the geocentric longitude; because, in either of those cases, the radius vector of the planet, and the straight line EP (fig. 72) drawn from it to the observer, are projected on the plane of the ecliptic in the same straight line ESL; and consequently the planet, whether seen from the earth or the sun, is referred to the same point of the ecliptic, excepting indeed the inferior planets, which in their inferior conjunctions are referred to points diametrically opposite. Let P, therefore, be the place of a planet in opposition; then, in the spherical triangle PNL, right-angled at L, the side NL, being the longitude of the planet minus that of the node, is given by observation (the longitude of the node being supposed to be previously determined); the inclination PNL is also known; therefore, by Napier's rules,

$$\tan. PN = \frac{\tan. NL}{\cos. PNL};$$

that is, the elongation of the planet is given in terms of its longitude and the inclination of its orbit. The same

Theoretical triangle PNL also affords data for determining the radius vector; for $\tan. PL = \tan. PNL \sin. NL$; but PL is the measure of the angle PSL, and consequently PSL, the heliocentric latitude, also becomes known. Now, in the triangle PES the angle PES is given by observation, therefore EPS ($= PSL - PES$) is also given; but $PS : SE :: \sin. PES : \sin. EPS$, whence $PS = SE \frac{\sin. PES}{\sin. EPS}$, or the radius vector is found in terms of the sun's distance from the earth and given angles.

In consequence of the incommensurable relation subsisting between the times of the periodic revolutions of the planets and that of the earth, the successive oppositions and conjunctions never take place at the same points of the orbits; therefore, by making a number of similar observations, as many different angles of elongation and radii vectores will be found, which, unless the orbits are circular, will all have different values. By computing, therefore, the values of these radii vectores in terms of the greater axis of the earth's orbit, and laying them down in their true positions round the sun, we shall obtain an approximation to the curve described by the planet on the plane of its orbit. A few observations of this sort will suffice to show that the orbit is eccentric; and as we have already seen that the solar orbit is an ellipse, analogy will immediately suggest the probability that that of the planet is also an ellipse, having the sun in one of its foci. It is easy to determine whether this be the case or otherwise. Three points given by position on a plane completely determine an ellipse of which a focus is known: having therefore computed an ellipse which satisfies three observations of a planet, its periphery, if the hypothesis of elliptic motion is correct, will comprehend all the places of the same planet computed from any other observations. Now, it is found that this is what takes place with regard to every one of the planets; hence results the first of the three laws discovered by Kepler which form the basis of the whole system of modern astronomy, namely, that the *orbits of the planets are ellipses, of which the sun occupies one of the foci.*

By a comparison of the sectors formed by two contiguous radii vectores and the arcs included between them, with the time consumed by the planet in describing those arcs, Kepler was led to the discovery of the second great law of the planetary motions, namely, that *the areas described by the radius vector of a planet are proportional to the times employed in describing them.* The data from which this important conclusion was deduced were not rigorously exact; but the fact itself has been confirmed by an infinity of observations since the time of Kepler; and Newton, by the application of geometry to dynamics, demonstrated that it is *necessarily* true of all motions regulated by a central force, whatever the nature of that force may be.

Kepler having, by means of the most laborious computations, established the existence of these two laws with regard to each of the planets separately, next undertook to discover whether any analogy could be found regulating their mean distances from the sun. As there were only six planets known in his time, he commenced his investigation by comparing the intervals between their respective orbits with the five regular geometrical solids. Having failed in this speculation, and in various others suggested by a mind equally fertile and persevering, he at length, by a happy inspiration of genius, thought of comparing the mean distances of the planets with their respective periods of revolution, and soon perceived that the numbers which represent the periodic times of the planets, beginning with Mercury and ending with Saturn,

increase in a much greater ratio than those representing their mean distances from the sun. Jupiter, for example, is *four* times more distant from the sun than the earth is; but his period is *twelve* times greater than that of the earth. Kepler then tried the various powers of the distances and periods. Unfortunately an error of computation for some time concealed the discovery from him; but having resumed the subject, he at length found, on the 15th of May 1618 (and few days, as Mr Playfair has remarked, are more memorable in the annals of science), with all the delight which a great and important discovery gives rise to, that *the squares of the numbers which express the times of revolution are to one another as the cubes of those which express the mean distances of the planets from the sun.*

These three general laws, which are necessary consequences of the law of gravitation, directly as the masses, and inversely as the squares of the distances, greatly facilitate the investigation of the orbit of a newly discovered planet, and may even be regarded as more accurate than the results obtained from any moderate number of observations, however exact. Thus, instead of having recourse to observation for the determination of the radius vector, which cannot be found by direct observation but with considerable difficulty, it is preferable to deduce it by means of the third law from the planet's periodic time, which can always be determined with great precision, and with much greater facility. They also afford a strong analogical proof of the annual motion of the earth. In fact, if we compute from the third law the periodic time of a body placed at the same distance from the sun as the earth is known to be, the result will give exactly the sidereal year. It is therefore certain that the earth obeys the same laws as the planets; and, when classed among them, the most perfect analogy pervades the whole system.

The periodic time of a planet may be determined by observing the interval which elapses between two consecutive passages through the same node. The retrograde movement of the nodes being, as we have seen, inconsiderable, the planet, in returning to its node, also returns to the same position very nearly with reference to the fixed stars, and therefore has in the interval completed a sidereal revolution. Hence the mean sidereal motion is known, and consequently, from the third law of Kepler, the planet's mean distance from the sun, the double of which is the transverse axis of the orbit. But the observation of the passages through the nodes not only gives the time of a sidereal revolution, but also approximate values of the eccentricity and the position of the line of the apsides; for, unless the orbit is circular, or the line of the apsides coincides with that of the nodes, the time the planet consumes in passing from the ascending to the descending node, or from $\varnothing$ to $\varnothing$, will be different from that in which it passes from $\varnothing$ to $\varnothing$; and, by a comparison of this difference with the theory of elliptic motion, it is easy to deduce the greatest difference between the true and mean anomalies, that is, the greatest equation of the centre, and thence the eccentricity. The method is exactly similar to that which has already been described in chap. ii. sect. 2.

But as these methods lead to results of no great accuracy, and as the passages through the nodes in the case of the distant planets occur only after considerable intervals of time, the astronomer requires some more accurate and expeditious means of determining the elements of an orbit; and three geocentric observations of the planet in any part of its orbit whatever are sufficient to determine these elements, when the nodes and inclination, mean motion and mean distance, are known. Having already

First law
of Kepler.

Second law
of Kepler.

Theoretical
Astronomy.

Third law
of Kepler.

Theoretical Astronomy. explained in last section the manner in which the geocentric are converted into heliocentric longitudes, and reduced to the plane of the orbit, let us assume v, v', v'' , to represent three heliocentric longitudes so reduced, and π the longitude of the perihelion, also reduced to the plane of the orbit. The true anomalies corresponding to the three observations will consequently be $v - \pi, v' - \pi, v'' - \pi$. Now, if, as in the series given in chap. ii. sect. 2, for the true anomaly in terms of the mean, we express the mean motion by n , and the time elapsed since the passage through the perihelion by t , the three corresponding mean anomalies will be respectively nt, nt', nt'' ; and it will be observed, that although t is unknown, yet as $t' - t$ and $t'' - t$ (the intervals between the first and the other two observations) are known, t' and t'' are both given in terms of t .

Omitting the square, and all the higher powers, of the eccentricity e , the series just referred to gives the three following equations,

$$\begin{aligned} nt &= v - \pi - 2e \sin.(v - \pi) \\ nt' &= v' - \pi - 2e \sin.(v' - \pi) \\ nt'' &= v'' - \pi - 2e \sin.(v'' - \pi) \end{aligned}$$

from which we must deduce the three unknown quantities t, e, π , that is to say, the epoch of the planet's passage through the perihelion, the eccentricity, and the longitude of the perihelion. By subtracting the first of these equations from each of the other two, we obtain

$$\begin{aligned} n(t' - t) &= v' - v - 2e [\sin.(v' - \pi) - \sin.(v - \pi)] \\ n(t'' - t) &= v'' - v - 2e [\sin.(v'' - \pi) - \sin.(v - \pi)]; \end{aligned}$$

and if we assume

$$\begin{aligned} n(t' - t) - (v' - v) &= a \\ n(t'' - t) - (v'' - v) &= b \end{aligned}$$

(a and b being thus known quantities), these two equations give us the two following,

$$\begin{aligned} a &= -2e [\sin.(v' - \pi) - \sin.(v - \pi)] \\ b &= -2e [\sin.(v'' - \pi) - \sin.(v - \pi)]; \end{aligned}$$

whence, by division,

$$\frac{a}{b} = \frac{\sin.(v' - \pi) - \sin.(v - \pi)}{\sin.(v'' - \pi) - \sin.(v - \pi)}$$

Now, the numerator of this fraction

$$\begin{aligned} &= \sin.(v - \pi) \left\{ \frac{\sin.(v' - \pi)}{\sin.(v - \pi)} - 1 \right\} \\ &= \sin.(v - \pi) \left\{ \frac{\sin.v' \cos.\pi - \cos.v' \sin.\pi}{\sin.v \cos.\pi - \cos.v \sin.\pi} - 1 \right\} \\ &= \sin.(v - \pi) \left\{ \frac{\sin.v' - \sin.v - \tan.\pi (\cos.v' - \cos.v)}{\sin.v - \cos.v \tan.\pi} \right\}; \end{aligned}$$

and, similarly, the denominator

$$= \sin.(v - \pi) \left\{ \frac{\sin.v'' - \sin.v - \tan.\pi (\cos.v'' - \cos.v)}{\sin.v - \cos.v \tan.\pi} \right\};$$

therefore

$$\frac{a}{b} = \frac{\sin.v' - \sin.v - \tan.\pi (\cos.v' - \cos.v)}{\sin.v'' - \sin.v - \tan.\pi (\cos.v'' - \cos.v)};$$

whence

$$\tan.\pi = \frac{a(\sin.v'' - \sin.v) - b(\sin.v' - \sin.v)}{a(\cos.v'' - \cos.v) - b(\cos.v' - \cos.v)};$$

an equation which gives π , the longitude of the perihelion reduced to the orbit, the angles v, v', v'' , being given by observation.

Having thus found π , and consequently $v' - \pi, v'' - \pi$, it is easy to determine the eccentricity e . From the equation

$$a = -2e [\sin.(v' - \pi) - \sin.(v - \pi)]$$

we obtain

$$2e = -\frac{a}{\sin.(v' - \pi) - \sin.(v - \pi)};$$

a formula which may be rendered better adapted for logarithmic calculation by being put under the form

$$e = -\frac{a}{4 \sin.\frac{v' - v}{2} \cdot \cos.\left(\frac{v' + v}{2} - \pi\right)}.$$

By means of the values of e and $v - \pi$, which have now been found, we obtain t , the epoch of the passage of the planet through its perihelion, immediately from the equation

$$nt = v - \pi - 2e \sin.(v - \pi).$$

The only element which now remains undetermined is the radius vector, and this is given by the polar equation of the ellipse, viz.

$$r = \frac{a(1 - e^2)}{1 + e \cos.(v - \pi)},$$

in which a represents the semi-axis major, or mean distance found by the third law of Kepler.

In this manner approximate values of the different elements are obtained, but no method can be proposed which will give them, without repeated corrections, so accurately as to accord with the precise observations of the present day; and the great object of the practical astronomer is to advance them gradually nearer and nearer to the truth. From the laws of Kepler applied to a few observations, formulæ are constructed which represent the mean values of the elliptic elements nearly; every successive observation gives a geocentric latitude and longitude; and by comparing these with the corresponding latitude and longitude computed from the formulæ, equations of condition are obtained, by means of which the formulæ are corrected and rendered still more exact. New observations give new equations of condition, to be joined with the former; and after a great number of such equations have been obtained, geometry teaches us how to combine them so that each may have its just influence in the determination of the final result. Thus the tables are gradually approximated to perfection, or to such a state that they differ only insensibly from the mean of a great number of observations.

But the great difficulty of obtaining an exact conformity between observation and the results of computation arises from the circumstance that the different elements of the orbits have no fixed values, but are incessantly though slowly varying, in consequence of the mutual disturbances which the planets occasion to the motions of each other. If the planets had no mutual attraction, and obeyed only the central force of the sun, the problem of determining the different circumstances of their motion would be one of easy solution, and each of them would accurately describe an ellipse on the plane of its orbit, according to the laws of Kepler. In consequence, however, of their mutual attraction, every planet is compelled to deviate more or less from its ellipse; so that when the matter is viewed with mathematical precision, the laws of Kepler belong only to an ideal system, and have no actual existence in nature. It is in the determination of the amount of these causes of perturbation, and the secular variations they give rise to, that the most profound and intricate theories of physical astronomy find their application; for it is from theory alone that we can derive any knowledge of the laws and periods of changes which are completed only after many hundreds or thousands of years. The planets whose motions are most disturbed by their mutual attractions are Jupiter and Saturn; and even with respect to them, observation, although it makes

Theoretical known the existence of inequalities, can neither detect their laws nor assign their periods. The only elements which are exempted from secular changes occasioned by the perturbing forces are the greater axes of the orbits, and the mean motions depending on them according to the third law of Kepler. The eccentricities of the orbits vary slowly. With regard to Mercury, Mars, and Jupiter, those elements are at the present time increasing; in the cases of Venus, the Earth, Saturn, and Uranus, they are diminish-

Theoretical ing. The perihelia are also gradually shifting their places on the planes of the orbits. These motions are direct in the case of all the planets excepting Venus, the perihelion of whose orbit, when referred to the fixed stars, moves in a direction contrary to that of the signs.

The following table exhibits the mean motions of the planets, and the elements and positions of their ellipses on the planes of their orbits, at the commencement of the year 1801. For the four new planets the epoch is 1820.

Planet.	Mean Sidereal Revolution.	Mean Distance.	Eccentricity.	Secular Variation of Eccentricity.	Longitude of Perihelion.	Ann. Var. of Longitude of Perihelion.	Mean Longitude of Planet.
Mercury	87 ^d 969258	0.387098	0.20551494	+ 0.00000386	74° 21' 46".9	+ 55".9	166° 0' 48".6
Venus...	224.700786	0.723331	0.00686074	— 0.00006271	128 43 53.1	+ 47.4	11 33 3.0
Earth....	365.256361	1.000000	0.01678356	— 0.00004163	99 30 5.0	+ 61.8	100 39 10.2
Mars.....	686.979645	1.523692	0.09330700	+ 0.00009017	332 23 56.6	+ 65.9	64 22 55.5
Vesta....	1325.743100	2.367870	0.08913000		249 33 24.4	+ 94.2	278 30 0.4
Juno.....	1592.660800	2.669009	0.25784800		53 33 46.0		200 16 19.1
Ceres....	1681.393100	2.767245	0.07843900		147 7 31.5	+ 121.3	123 16 11.9
Pallas....	1686.538800	2.772886	0.24164800		121 7 4.3		108 24 57.9
Jupiter...	4332.584821	5.202776	0.04816210	+ 0.00015935	11 8 34.6	+ 57.1	112 15 23.0
Saturn...	10759.219817	9.583786	0.05615050	— 0.00031240	89 9 29.8	+ 69.5	135 20 6.5
Uranus...	30686.820829	19.182390	0.04667938		167 31 16.1	+ 52.5	177 48 23.0

3. Of the real Dimensions of the Planetary Orbits, and the Transits of Venus and Mercury over the Sun's Disk.

—In what has hitherto been said respecting the mean distances of the planets from the sun, those distances have been estimated in parts of the semi-axis major of the earth's orbit; a convenient scale, which enables us to form a very precise idea of the relative dimensions of the several orbits, and likewise serves to express their absolute dimensions, provided we can determine the distance between the sun and the earth in terms of any measure with which we are familiar. It is evident, indeed, in consequence of the relation that subsists between the mean distances and mean motions, that it is only necessary to determine the mean distance of any one of the planets from the sun, in order to determine the mean distances of all the others, and assign the dimensions of the whole solar system. Now there are various ways of determining the sun's distance from the earth in terms of the earth's semidiameter. The distance of a planet from the sun may likewise be obtained if we can find the means of measuring its distance from the earth at any epoch; for the geocentric positions of the sun and the planet being known from the theory of their motions, the radius vector of the orbit, or planet's distance from the sun at that epoch, may be found by a simple trigonometrical computation. To determine the distance of a planet from the earth, it might seem only necessary to determine its horizontal parallax; but in general the parallaxes of the planets are quantities by far too small to be directly observed. That of Mars, however, becomes very appreciable in particular circumstances, that is to say, when Mars is in opposition with the sun, and at the same time near the perihelion of his orbit. Thus, in the year 1751, on the 6th of October, that planet, being near his opposition, was observed at the same instant of time by Lacaille at the Cape of Good Hope, and by Wargentin at Stockholm; and the horizontal parallax deduced from the two observations, in the manner explained in chap. i. sect. 2, was found to amount to 24".6. Now the distance of the planet being equal to unity divided by the sine of the horizontal parallax, the distance of Mars from the earth at the time of the observation was consequently

$$1 \div \frac{24".6 \times 3.1416}{180^\circ \times 60 \times 60} = \frac{648000}{77.28} = 8381 \text{ terrestrial radii.}$$

But the distance of Mars from the earth at that time, as computed from the theory of his elliptic motion, was 0.435 parts of the radius of the earth's orbit; consequently the whole length of that radius is $\frac{1 \times 8381}{0.435} = 19226$

semidiameters of the earth. Hence the distance of Mars from the sun = 19226 + 8381 = 27607 semidiameters of the earth. It will be remarked that these numbers are only approximative, our present object being to explain the method, and not to determine the exact quantities.

But besides the inconvenience attending the determination of a planet's distance by this method, which requires observations to be made simultaneously on opposite sides of the earth, the method is in itself liable to great uncertainty. The error of a result is always in a certain proportion to the error of observation, and in the present case a very large quantity is to be determined from a very small one; hence a very slight error of observation will occasion a very erroneous result in the computation of the mean distance. It would be difficult in a single observation of this nature to answer for an error of 2"; but here 2" is a twelfth part of the whole parallax; consequently an uncertainty amounting to a twelfth part affects the mean distance.

A much more accurate method of determining the sun's distance, and thence the dimensions of the planetary orbits, is afforded, though rarely, by the transits of Venus over the sun's disk. When Venus is at her inferior conjunction, and at the same time very near her node, her body will be projected on the disk of the sun; and through the effect of her proper motion, combined with that of the earth, she will appear as a dark spot passing over the disk, and describing a chord which will be seen under different aspects by spectators placed at different points on the earth, because, by reason of the parallax, they refer the planet to different points on the solar disk. The position of the spectator not only occasions a difference in the apparent path described by the planet, but has also a very sensible influence on the duration of the transit, in consequence of which the parallaxes both of Venus and the sun can be determined with great exactness. In order to illustrate this, let E (fig. 73) represent the earth, V Venus, and S the sun. An observer placed at E, the centre of the earth, would see Venus in the di-

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rection of the visual ray EV: she would consequently appear to him projected on the sun's disk at S, and in her successive positions would appear to describe the line DS. Other observers placed at O' and O'' on the earth's surface would see the planet at V' and V'': to the first she would appear to describe the chord D'V', and to the second D''V''. This is a necessary result of the difference of the parallaxes of Venus and the sun; and as the chords D'V', D''V'' differ in length according as they are more or less remote from the centre of the disk, the duration of the transit will be longer or shorter according to the situation of the observer and the geocentric latitude of the planet. If by reason of the relative parallax the time of a transit is longer than the true time in one hemisphere, it will be shorter in the opposite; and hence the difference of the times (which may be observed with great accuracy) at places having very different latitudes may serve to determine the relative parallax, or the difference between the parallax of Venus and that of the sun. But the parallaxes are reciprocally proportional to the distances; and the ratio of the distances being known, therefore the ratio of the parallaxes is also known; and having thus the ratio and the difference of the two parallaxes, it is easy to compute the separate amount of each.

This particular application of the transits of Venus to the determination of the sun's distance was first pointed out by Dr Halley, when he announced the transits of 1761 and 1769. Kepler had before announced the occurrence of a transit, but he regarded it only as a curious, and till that time unobserved, phenomenon.

The transit of Venus which occurred in 1769 was anxiously expected by astronomers, and observed in many different parts of the world. The result of the whole of the observations renders it extremely probable that the parallax of the sun is included within the limits of 8''.5 and 8''.7. The mean 8''.6 has been adopted by Delambre and Lalande. From the following table, computed from the different observations, and published by Delambre in the second volume of his *Astronomie*, p. 505, an idea may be formed of its probable accuracy. Delambre, indeed, remarks that the sun's parallax is now sufficiently well known for all the practical purposes of astronomy.

Places of Observation.	Sun's Parallax.	Difference of Parallaxes.
Otaheite, Wardhus.....	8''.7094	21''.561
Otaheite, Kola.....	8''.5503	21''.166
Otaheite, Cajaneburg.....	8''.3865	20''.762
Otaheite, Hudson's Bay.....	8''.5036	21''.066
Otaheite, Paris and Petersburg.....	8''.7780	21''.730
California, Wardhus.....	8''.6160	21''.330
California, Kola.....	8''.3880	20''.765
California, Cajaneburg.....	8''.1636	20''.208
California, Hudson's Bay.....	8''.1521	20''.284
California, Paris and Petersburg.....	8''.7155	21''.576
Hudson's Bay, Wardhus.....	9''.1260	22''.592
Hudson's Bay, Kola.....	8''.4589	20''.941
Hudson's Bay, Cajaneburg.....	8''.1730	20''.233
Hudson's Bay, Paris and Petersburg.....	9''.2491	22''.897

Here the mean of the first 5 results is nearly...8''.59
of the next 5.....8''.41
of the next 4.....8''.75
of all.....8''.57

Having once obtained the value of the solar parallax, it is easy to deduce the sun's distance, and consequently the

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dimensions of all the planetary orbits. For this purpose we have

$\sin. 8''.6 : 1 :: \text{radius of earth} : \text{sun's distance};$
that is, on reducing the radius of a circle to seconds,
 $\text{sun's distance} = \frac{360^\circ \times 60 \times 60}{8.6 \times 2 \times 3.14159} = 23984 \text{ terrestrial radii.}$

Now, if we assume the semidiameter of the earth to be 4000 miles in round numbers, the distance of the sun, or radius of the earth's orbit, will consequently be $23984 \times 4000 = 95936000$ miles.

By means of this value the mean distances of the planets from the sun, which in the table given above were expressed in terms of the mean distance of the earth, may be converted into miles. The following are the results in round numbers.

Planet.	Mean Distance from the Sun in Miles.
Mercury.....	37,000,000
Venus.....	68,000,000
Earth.....	95,000,000
Mars.....	142,000,000
Ceres.....	262,000,000
Jupiter.....	485,000,000
Saturn.....	890,000,000
Uranus.....	1,800,000,000

The transits of Venus being phenomena of great importance, in consequence of their practical application to the problem of the sun's distance, it becomes interesting to determine the periods at which they successively occur. It is evident that, by reason of the inclination of the orbit, they can only take place when Venus is very near one of her nodes. Two conditions must therefore be satisfied: Venus must be within a short distance of her node, and at the same time in her inferior conjunction. Now, the interval between two successive conjunctions, that is, the period of a synodic revolution, is easily deduced from the sidereal revolutions of the planet and the earth. Thus, generally, let A and B be two planets, T and t the times of their sidereal revolutions respectively, and suppose T to be greater than t. In the time T, A describes a complete circumference, therefore $T : t :: 1 : \frac{t}{T}$ = part of a circumference described by A in the time t. But during the same time t, B describes a whole circumference; therefore $1 - \frac{t}{T}$ is what B gains on A in the time t. But the successive conjunctions will always take place when B has gained a whole circumference; therefore, denoting by S the interval between two successive conjunctions, we have $1 - \frac{t}{T} : 1 :: t : S$, whence $S = \frac{Tt}{T-t}$.

From this simple formula the synodic revolution of any of the planets is found by substituting for T and t the times of the sidereal revolutions of the earth and planet. Suppose, for example, we wish to find the time of a synodic revolution of Mercury. In this case $T = 365.256$ days, and $t = 87.969$ days; consequently $T - t = 277.287$, and $S = \frac{365.256 \times 87.969}{277.287} = 115.877$ days, which, therefore, is the time of a synodic revolution of Mercury.

In the case of Venus we have $t = 224.700$, whence $T - t = 365.256 - 224.700 = 140.556$, and consequently $S = \frac{365.256 \times 224.700}{140.556} = 583.92$ days; which is the period of her synodic revolution.

D

Theoretical Astronomy. Let us next attend to the other condition which must be satisfied before a transit can take place, namely, that the planet has returned to its node as well as to its inferior conjunction. If we represent by m the number of revolutions of the earth in the required period, and by n the number of synodic revolutions of the planet in the same

time, it is evident that we shall have $mT = \frac{nTt}{T-t}$, whence

$$\frac{m}{n} = \frac{t}{T-t}. \quad \text{In the case of Mercury, therefore, } \frac{m}{n} =$$

$\frac{87969}{277287}$; that is to say, after 87969 years, in the course of which Mercury will have been 277287 times in conjunction, the earth and Mercury will be again in conjunction, occupying the same points of their orbits as at the commencement of the period, supposing the nodes fixed. But periods of such enormous length are of no practical use: it is necessary to find an approximating ratio expressed by smaller numbers. For this purpose it is convenient to have recourse to the method of continued fractions, from which the following series is obtained:—

$$\frac{87969}{277287} = \frac{1}{3} + \frac{1}{6} + \frac{1}{10} + \frac{1}{7} + \frac{136}{1079}.$$

Here the first approximating fraction is $\frac{1}{3}$, which denotes that in one year, during which there will happen three synodic periods, Mercury will not be very far from his conjunction, nor from the same point of his orbit in which he was at the commencement of that time. The

next approximation is $\frac{1}{3} + \frac{1}{6} = \frac{6}{19}$, showing that after six years, during which there will have been 19 conjunctions, Mercury will be again nearly in conjunction at the same point of his orbit. By continuing the process we obtain the following series of fractions, each approaching nearer

to $\frac{87969}{277287}$, namely,

$$\frac{1}{3}, \frac{6}{19}, \frac{7}{22}, \frac{13}{41}, \frac{33}{104}, \frac{46}{145}, \text{ \&c.}$$

of which the numerators express the number of years, and the denominators the corresponding number of synodic revolutions.

Approximative fractions might be found in the same manner to express the ratio of the number of revolutions of Mercury to those of the earth, or of $\frac{t}{T}$; but it is unnecessary to have recourse again to division, inasmuch as they are easily obtained from the above. For example, since the fraction $\frac{1}{3}$ denotes that Mercury has gained three revolutions on the earth in one year, it is evident that he must have completed $3+1=4$ revolutions. In the same way, in six years Mercury gains 19 on the earth, or completes $19+6=25$. Hence, in the series required the numerators of the fractions will continue the same as in the series above, while the denominators will be the sums of the terms of the corresponding fractions. The new series will therefore be

$$\frac{1}{4}, \frac{6}{25}, \frac{7}{29}, \frac{13}{54}, \frac{33}{137}, \frac{46}{191}, \text{ \&c.}$$

the numerators being the number of years, and the denominators the corresponding periods of Mercury.

Applying to the case of Venus and the earth the formula $\frac{m}{n} = \frac{t}{T-t}$, we shall have $t = 224.7008$, $T-t =$

$$365.2563 - 224.7008 = 140.5555; \text{ therefore } \frac{m}{n} = \frac{224.7008}{140.5555} \quad \text{Theoretical Astronomy.}$$

The series of fractions approximating to this ratio, obtained in the manner indicated above, is

$$\frac{1}{1}, \frac{2}{1}, \frac{3}{2}, \frac{8}{5}, \frac{227}{142}, \frac{235}{147}, \frac{243}{152}, \text{ \&c.}$$

the numerators of which, as before, express the years, and the denominators the synodic periods. Taking the fourth fraction of the series, it appears that after eight years, in which there are five synodic periods, Venus will again occupy nearly the same position with respect to the earth and the nodes of her orbit. This will take place more nearly after 227 years, and more nearly still after 235; consequently, 235 years after a transit has taken place, the occurrence of another may be expected with great probability. The alteration, however, which takes place in the position of the line of the nodes, which in the preceding computations we have regarded as fixed, renders the numbers a little uncertain.

Since Venus returns to her conjunction at nearly the same point of her orbit after eight years, it may happen, and sometimes indeed actually does happen, that a transit will take place in about eight years after the occurrence of a former one. But in that time the latitude of Venus, in consequence of the inclination of her orbit, undergoes a variation amounting to 20' or 24'; in sixteen years the change of latitude increases to 40' or 48', which is considerably greater than the diameter of the sun. It cannot happen, therefore, that three transits will take place within sixteen years. From the above series of fractions we might infer that another could not take place before 227 years; but that series was obtained on the supposition that the transits only happen when Venus returns to the same node; and it is evident that they may equally occur when the planet is near the other node, and consequently after an interval of half the length of the former, or 113 years. If, at the occurrence of the first transit, Venus has passed her node, the next will happen eight years sooner; or, if she has not reached the node, eight years later. Hence, after two transits have occurred within eight years, another cannot be expected before 105, 113, or 121 years, that is, 113 ± 8 years. But these periods sometimes fail: that of 235 brings about the phenomenon with greater certainty, and 243 (which is the double of 121) is the surest of all. The periods of 235 and 251 are that of 243 diminished or augmented by 8. The whole calculation, therefore, reduces itself to periods of 121 and ± 8 years. The last transits took place in 1761 and 1769; the next will not happen till the years 1874 and 1882; and thus the infrequency of these phenomena adds to the interest they derive from their real importance.

Delambre has given a list of all the transits of Venus for a period of 2000 years, from which the following is extracted. (*Astronomie*, tome ii. p. 473.)

Year.	Month.	Mean Time (at Paris) of Conjunction.	Node.
1631	Dec. 6.	17 ^h 28 ^m 40 ^s	♊
1639	Dec. 4.	6 9 40	♊
1761	June 5.	17 44 34	♊
1769	July 3.	10 7 54	♊
1874	Dec. 8.	16 17 44	♊
1882	Dec. 6.	4 25 44	♊
2004	June 7.	21 0 4	♊

Theoretical Astronomy. SECT. III.—Of the Physical Constitution of the Planets, their Magnitude, Rotation, and other remarkable objects.

Mercury.

Mercury is a small star, but emits a very bright white light, though, by reason of his always keeping near the sun, he is seldom to be seen; and when he does make his appearance, his return to the sun is so rapid, that he can only be discerned for a short space of time. Delambre was able to observe him only twice with the naked eye.

Mercury is about 3140 English miles in diameter, and his mean distance from the sun about 37 millions of miles. On account of his smallness and brilliancy it is extremely difficult to find any spot on his disk so distinctly marked as to afford the means of determining his rotation. Besides, by reason of his proximity to the sun, an observation of a spot, if made in the evening, can scarcely be well begun before the planet sets; or, if in the morning, before the increasing twilight renders the spot invisible. Hence it is only possible to observe daily a very small arc of a small circle; and if the spot re-appears on the succeeding day, it is doubtful whether the arc which it has passed over exhibits the whole motion, or if one or more circumferences ought to be added. By an attentive observation of the variations of the phases of Mercury, Schroeter has, however, remarked that he revolves about his axis in the space of 24 hours 5 minutes 30 seconds. M. Harding discovered in 1801 an obscure streak on the southern hemisphere of the planet, the observations of which, together with those of a spot discovered by Schroeter, gave the same period of rotation. The results of Schroeter's researches on Mercury may be summed up as follows: 1st, The apparent diameter of Mercury at his mean distance is $6''.02$; 2d, His form is spherical, exhibiting no sensible compression; 3d, His equator is very considerably inclined to his orbit, and the differences of his days and seasons must consequently be very great; 4th, There are mountains on his surface which cast very long shadows, and of which the height bears a greater proportion to the diameter of the planet than those of the Earth, the Moon, or even of Venus. The height of Chimborazo is $\frac{1}{1017}$ of the radius of the earth; one of the mountains in the moon has been estimated at $\frac{1}{214}$ of her radius; the highest in Venus at $\frac{1}{144}$; and one in Mercury at $\frac{1}{126}$. The highest mountains are in the southern hemisphere, which is also the case in respect of the Earth and Venus. There are no observations to prove decisively whether Mercury is surrounded by an atmosphere.

Venus.

Venus, the most beautiful star in the heavens, is about 7700 English miles in diameter, and placed at the distance of 68 millions of miles from the sun. Although the oscillations of this planet are considerably greater than those of Mercury, and she is seldom invisible, yet on account of the uniform brilliancy of her disk, it is extremely difficult to ascertain the period of her rotation. Dominic Cassini, after having long fruitlessly attempted to discover any object on her surface so well defined as to enable him to follow its motions, at length, in 1667, perceived a bright part, distant from the southern horn a little more than a fourth part of the diameter of the disk, and near the eastern edge. By continuing his observations on this spot, Cassini concluded the rotation of Venus to be performed in about 23 hours; but he does not seem to have considered this conclusion as deserving of much confidence. In the year 1726 Bianchini, an Italian astronomer, made a number of similar observations for the same purpose,

from which he inferred that the rotation of the planet is performed in 24 days 8 hours. The younger Cassini has shown, however, that the observations of Bianchini, as well as those of his father, could be explained by a rotation of 23 hours and 21 or 22 minutes, whereas the rotation of 24 days 8 hours cannot be reconciled with the appearances observed by the elder Cassini. The determination of Cassini was regarded by astronomers as the more probable of the two, particularly as Bianchini was not able to make his observations in a connected manner, on account that a neighbouring building intercepted his view of the planet, and obliged him to transport his telescope to a different situation. The question of the rotation of Venus was finally settled by Schroeter, who found it to be performed in 23 hours 21 minutes 19 seconds. Each of the three observers found the inclination of the axis of rotation to the axis of the ecliptic to be about 75° . Some doubt, however, still exists with respect to the value of this element.

Schroeter's observations on this planet were principally directed to a mountain situated near the southern horn. The line which joins the extremities of the horns is always a diameter; and the horns of the crescent of a perfect sphere ought to be sharp and pointed. Schroeter remarked that this was not always the case with regard to the horns of Mercury and Venus. The northern horn of the latter always preserved the pointed form, but the southern occasionally appeared rounded or obtuse,—a circumstance which indicated that the shadow of a mountain covered the part Bo (fig. 74), so that the line joining the extremities of the horns appeared to be Ao, and not AB (perpendicular to CD, the axis of the ecliptic); but at d , beyond oB , he remarked a luminous point, which he supposed to be the summit of another mountain, illuminated by the sun after he had ceased to be visible to the rest of that hemisphere. Now, in order that the horn of the crescent may appear obtuse in consequence of the shadow of a mountain falling upon it, and another mountain d present a luminous point, the two mountains must be at the same time both at the edge of the disk and on the line separating the dark from the enlightened part of the planet. But this position cannot be of long continuance; for the rotation will cause d to rise into the enlightened part, or sink into the dark hemisphere, and in either case the mountain will cease to be visible. If, however, the rotation is completed in 23 hours 21 min., the mountain d will appear 39 min. sooner than it did on the previous day; for in the course of a day the boundary of light and darkness will hardly have shifted its position on the surface of the planet through the effects of the orbital motion. Hence it is possible to obtain several consecutive observations, from which an approximate value of the period may be found; and this being once obtained, it may be rendered still more exact by observations separated from each other by a longer interval. Thus Schroeter found that an interval of 20 days 11 hours 15 min. between two apparitions of the mountain being divided by 23 hours 21 min., gave 21.005 revolutions. That intervals of 121 days 14 hours 25 min., 142 days 1 hour 40 min., 155 days 18 hours 11 min., divided each by 23 hours 21 min., gave 125.01, 146.02, 165.09 revolutions respectively. All these comparisons prove that the revolution of 23 hours 21 min. is somewhat too short. They ought to have given 21, 125, 146, and 165 revolutions exactly, supposing the observations to have been perfectly accurate. On dividing the intervals by 21, 125, 146, and 165 respectively, the quotients will be each the time of a revolution very nearly; and by taking a mean among the whole, the most pro-

Theoretical Astronomy. bable result at least will be obtained. In this manner Schroeter found the period of rotation already stated, namely, 23 hours 21 min. 19 sec.

Since the time of rotation of Mercury and Venus is nearly equal to that of the earth, the compression of these planets at the poles, which results from the centrifugal force, ought also to be nearly in the same proportion. But at the distance of the earth the compression must be imperceptible even in the case of Venus; for, supposing it to amount to $\frac{1}{300}$, the difference between the radius of her poles and that of her equator would only amount to a tenth of a second as seen from the earth.

Atmosphere of Venus.

During the transits of Venus over the sun's disk in 1761 and 1769 a sort of penumbral light was observed round the planet by several astronomers, which was occasioned, without doubt, by the refractive powers of her atmosphere. Wargentin remarked that the limb of Venus which had gone off the sun showed itself with a faint light during almost the whole time of emersion. Bergman, who observed the transit of 1761 at Upsal, says that at the ingress the part which had not come upon the sun was visible, though dark, and surrounded by a crescent of faint light, as in fig. 75; but this appearance was much more remarkable at the egress; for as soon as any part of the planet had disengaged itself from the sun's disk, that part was visible with a like crescent, but brighter (fig. 76). As more of the planet's disk disengaged itself from that of the sun, the part of the crescent farthest from the sun grew fainter, and vanished, until at last only the horns could be seen, as in fig. 77. The total immersion and emersion were not instantaneous; but as two drops of water, when about to separate, form a ligament between them, so there was a dark shade stretched out between Venus and the sun, as in fig. 78; and when this ligament broke, the planet seemed to have got about an eighth part of her diameter from the limb of the sun (fig. 79). The numerous accounts of the two transits which have been published abound with analogous observations, indicating the existence of an atmosphere of considerable height and density. Schroeter calculated that its horizontal refraction must amount to $30' 34''$, differing little from that of the terrestrial atmosphere. A twilight which he perceived on the cusps afforded him the data from which he deduced this conclusion.

Cassini and Montaigne imagined that they had observed a satellite accompanying Venus; but this appears to have been an optical illusion arising from the strong light of the planet reflected back from the convex surface of the eye upon the eye-glass of the telescope, and thence reflected a second time back to the eye. This hypothesis at least will explain the appearances which they have described; and although astronomers have sought for this pretended satellite with great care, they have neither observed it on the sun during the transits of Venus in 1761 and 1769, nor in any other part of her orbit.

Mars.

After Venus, Mars is the planet whose orbit is nearest to the earth. His diameter is about one half, and his volume only about one fifth part of that of our globe. He is of a dusky reddish colour, by reason of which he is easily recognised in the heavens. His mean distance from the sun is about 142 millions of miles.

The rotation of Mars was suspected before the year 1643 by Fontana, a Neapolitan astronomer; but it was reserved for Cassini to demonstrate its existence and assign its period. Cassini began to observe the spots on the surface of Mars at Bologna in 1666; and after having continued his observations for a month, he found they re-

turned to the same situation in 24 hours and 40 min. The planet was observed by some astronomers at Rome with longer telescopes; but they assigned to it a rotation of 13 hours only. This, however, was afterwards shown by Cassini to have arisen from their not distinguishing between the opposite sides of the planet, which, it seems, have spots pretty much alike. He made further observations on the spots of this planet in 1670; which confirmed his former conclusion respecting the time of rotation. The spots were again observed in subsequent oppositions, particularly for several days in 1704 by Maraldi, who took notice that they were not always well defined, and that they not only changed their shape frequently in the interval between two oppositions, but even in the space of a month. Some of them, however, continued of the same form long enough to allow the time of the planet's rotation to be determined. Among these there appeared that year an oblong spot, resembling one of the belts of Jupiter when broken. It did not reach quite round the body of the planet; but had, not far from the middle of it, a small protuberance towards the north, so well defined that Maraldi was thereby enabled to fix the period of its revolution at 24 hours 39 min., only one minute less than what Cassini had determined it to be.

The near approach of Mars to the earth in 1719 afforded an excellent opportunity of observing him, as he was then within $2\frac{1}{2}^\circ$ of his perihelion, and at the same time in opposition to the sun. His apparent magnitude and brightness were thus so much increased, that he was by the vulgar taken for a new star. His appearance at that time, as seen by Maraldi through a telescope of 34 feet long, is represented in fig. 80. There was then a long belt that reached half-way round, to the end of which another shorter belt was joined, forming an obtuse angle with the former, as in fig. 81. This angular point was observed on the 19th and 20th of August, a little to the east of the middle of the disk; and 37 days after, on the 25th and 26th of September, it returned to the same situation. This interval, divided by 36, the number of revolutions contained in it, gives 24 hours 40 minutes for the period of one revolution; a result which was verified by another spot of a triangular shape, one angle whereof was towards the north pole, and the base towards the south, and which on the 5th and 6th of August appeared as in fig. 82. After 72 revolutions it returned to the same situation on the 16th and 17th of October. Some of the belts of this planet are said to be parallel to his equator; but that seen by Maraldi was very much inclined to it.

Besides these dark spots on the surface of Mars, astronomers had noticed that a segment of his globe about the south pole exceeded the rest of his disk so much in brightness, that it appeared to project as if it were the segment of a larger globe. Maraldi informs us that this bright spot had been taken notice of for 60 years, and was more permanent than the other spots on the planet. One part of it is brighter than the rest, and the least bright part is subject to great changes, and has sometimes disappeared.

A similar though less remarkable brightness about the north pole of Mars was also sometimes observed, the existence of which has been confirmed by Sir W. Herschel, who examined the planet with telescopes of much greater power than any former astronomer ever was in possession of. A very full account of Herschel's observations on this planet is given in the 74th volume of the *Philosophical Transactions*. Some of the remarkable appearances there described are represented in fig. 83-88. The magnifying powers he used were sometimes as high

Bright spots about the poles of Mars.

Herschel's account of these spots.

Theoretical as 932; and with this the south polar spot was found to be 41" in diameter. Fig. 96 shows the connection of the other figures marked 89, 90, 91, 92, 93, 94, 95, which complete the whole equatorial succession of spots on the disk of the planet. "The centre of the circle," Herschel observes, "marked 90, is placed on the circumference of the inner circle, by making its distance from the circle, marked 92, answer to the interval of time between the two observations, properly calculated and reduced to sidereal measure. The same is done with regard to the circles marked 91, 92, &c.; and it will be found by placing any one of these connected circles in such a manner as to have its contents in a similar situation with the figures in the single representation, which are marked with the same number, that there is a sufficient resemblance between them; though some allowance must be made for the distortions occasioned by this kind of projection."

From these observations Herschel concluded that the diurnal rotation of Mars is accomplished in 24 hours 39 minutes 21½ seconds; that his equator is inclined to his orbit in an angle of 28° 42', and his axis of rotation to the axis of the ecliptic in an angle of 30° 18'. Hence the time of rotation and the seasons of this planet are little different from those of the earth.

The bright appearance so remarkable about the poles of Mars is ascribed by Herschel to the reflection of light from mountains of ice and snow accumulated in those regions. "The analogy between Mars and the earth," says he, "is perhaps by far the greatest in the whole solar system. Their diurnal motion is nearly the same, the obliquity of their respective ecliptics not very different; of all the superior planets, the distance of Mars from the sun is by far the nearest alike to that of the earth; nor will the length of the Martial year appear very different from what we enjoy, when compared to the surprising duration of the years of Jupiter, Saturn, and the Georgium Sidus. If we then find that the globe we inhabit has its polar region frozen and covered with mountains of ice and snow, that only partly melt when alternately exposed to the sun, I may well be permitted to surmise, that the same causes may probably have the same effect on the globe of Mars; that the bright polar spots are owing to the vivid reflection of light from frozen regions; and that the reduction of those spots is to be ascribed to their being exposed to the sun."

Since the discovery of the flattened form of the earth, it was to be presumed that the rotation of the other planets would produce a similar effect on their figures, and this supposition has been fully confirmed by observation. The time of the rotation of Mars is nearly equal to that of the earth, but his diameter being only about half that of the earth, the velocity of a point on his equator is consequently only half as great as that of a point on the earth's equator: hence we might expect that the deviation of his figure from a perfect sphere would be much less considerable. The contrary, however, appears to be the case; and his compression seems to be much greater than that of the earth. According to Herschel, the ratio of his equatorial and polar axes is 103 to 98. Schroeter estimates the same ratio to be that of 81 to 80. This remarkable compression at the poles of Mars arises in all probability from considerable variations of density in the different parts of his globe.

It has been commonly related by astronomers, that the atmosphere of this planet is possessed of such strong refractive powers as to render invisible the small fixed stars near which it passes. Dr Smith relates an observation of Cassini, in which a star in the water of Aquarius, at

the distance of six minutes from the disk of Mars, became so faint before its occultation, that it could not be seen by the naked eye, nor even with a three feet telescope. This would indicate an atmosphere of a very extraordinary size and density; but the following observations of Herschel seem to show that it is of much smaller dimensions. "1783, Oct. 26th. There are two small stars preceding Mars, of different sizes; with 460 they appear both dusky red, and are pretty unequal; with 218 they appear considerably unequal. The distance from Mars of the nearest, which is also the largest, with 227, measured 3' 26" 20". Some time after, the same evening, the distance was 3' 8" 55", Mars being retrograde. Both of them were seen very distinctly. They were viewed with a new 20 feet reflector, and appeared very bright. October 27th: the small star is not quite so bright in proportion to the large one as it was last night, being a good deal nearer to Mars, which is now on the side of the small star; but when the planet was drawn aside, or out of view, it appeared as plainly as usual. The distance of the small star was 2' 5" 25". The largest of the two stars," adds he, "on which the above observations were made, cannot exceed the 12th, and the smallest the 13th or 14th magnitude; and I have no reason to suppose that they were any otherwise affected by the approach of Mars, than what the brightness of its superior light may account for. From other phenomena it appears, however, that this planet is not without a considerable atmosphere; for, besides the permanent spots on its surface, I have often noticed occasional changes of partial bright belts, and also once a darkish one in a pretty high latitude; and these alterations we can hardly ascribe to any other cause than the variable disposition of clouds and vapours floating in the atmosphere of the planet."

Ceres, Pallas, Juno, and Vesta.

The commencement of the present century was rendered remarkable in the annals of astronomy by the discovery of four new planets circulating between Mars and Jupiter. Kepler, from some analogy which he found to subsist among the distances of the planets from the sun, had long before suspected the existence of one at this distance; and his conjecture was rendered more probable by the discovery of Uranus, with regard to which the analogy of the other planets is observed. So strongly, indeed, were astronomers impressed with the idea that a planet would be found between Mars and Jupiter, that, in the hope of discovering it, Baron Zach formed an association of 24 observers, who divided the sky into as many zones, and undertook each to explore one carefully. A fortunate accident anticipated a discovery which might have required years of toil. An error in the catalogue of Wollaston, who had laid down a star in a position in which it is not to be found, engaged Piazzi, the superintendent of the observatory at Palermo, to observe for several successive days all the small stars in the neighbourhood of the place indicated. On the first day of the present century, the 1st of January 1801, he observed a small star in Taurus, which, on the day following, appeared to have changed its place. On the 3d he repeated his observation, and was then satisfied that it had a diurnal motion of about 4' in right ascension, and 3½' in declination towards the north pole. He continued to observe it till the 23d, when he communicated his discovery to MM. Bode and Oriani, giving them the positions of the star on the 1st and 23d, and only adding, that between the 11th and 13th its motion had changed from retrograde to direct. Before the communication reached them, however, the planet was lost in the sun's rays; and, owing to its ex-

Atmo-
sphere of
Mars.

Theoretical Astronomy. treme smallness, the difficulty of finding it after its emergence was so great, that it was not again seen till the 31st of the following December, when it was detected by Zach. In this was recognised the planet which Kepler had suspected to circulate between Mars and Jupiter. Piazzi, in honour of Sicily, gave it the name of the tutelary goddess of that country, *Ceres*; and her emblem, the sickle, ♄, has been adopted as its appropriate symbol.

Ceres is of a reddish colour, and appears to be about the size of a star of the eighth magnitude. The eccentricity of her orbit is somewhat greater than that of Mercury; and its inclination to the ecliptic greater than that of any of the old planets. The distance of Ceres from the sun is about 3.2 times that of the earth, or nearly 270 millions of miles. Schroeter found her apparent diameter to be 2", corresponding to about 1624 miles; but Herschel reduced this measurement to 0".5, which would indicate a diameter of about 160 miles. The nebulosity which surrounds the planet renders it almost impossible to distinguish the true disk; and hence arises the great discrepancy between the above estimates of its magnitude. From a great number of observations, Schroeter inferred that Ceres has a dense atmosphere, rising to the height of no less than 675 English miles above the planet, and subject to numerous changes. On this account he conceives that there is little chance of discovering the period of its rotation.

Discovery of Pallas. The difficulty of finding Ceres induced Dr Olbers of Bremen to examine with particular care the configurations of all the small stars situated near her geocentric path. On the 28th of March 1802 he observed a star of the seventh magnitude, which formed an equilateral triangle with the stars 20 and 191 of Virgo in Bode's catalogue. He was certain that he had never seen a star in that place before, and at first imagined it might be one of those which are subject to periodical changes of brilliancy; but after examining it for two hours, he remarked that its right ascension was diminishing, while its northern declination continued to augment nearly in the same manner as had been the case with Ceres when that planet was first seen by him in almost the same position. On the following day he found its right ascension had diminished 10', while its northern declination had increased 20'. From observations continued during a month, M. Gauss calculated an elliptic orbit, the eccentricity of which amounted to .24764, much greater than that of any of the other planets. He also found its inclination to be 34° 39', exceeding the aggregate inclinations of all the other planetary orbits; and its mean distance 2.770552, almost the same as that of Ceres. On account of these three circumstances, the new planet, otherwise of little importance, became the most singular in the whole system. One planet had been suspected to exist between Mars and Jupiter, and two were now discovered. The great inclination of the last rendered it necessary to enlarge the boundaries of the zodiac; but the extent of the zodiac is entirely arbitrary, and had been limited by the extreme latitudes of Venus. There is no reason, as Delambre remarks, why it may not be extended even to the poles. Dr Olbers gave the new planet the name of Pallas, choosing for its symbol the lance, ♃, the attribute of Minerva.

The most surprising circumstance connected with the discovery of Pallas was the existence of two planets at nearly the same distance from the sun, and apparently having a common node. On account of this singularity Dr Olbers was led to conjecture that Ceres and Pallas are only fragments of a larger planet, which had formerly circulated at the same distance, and been shattered by

some internal convulsion. Lagrange made this hypothesis the subject of an ingenious memoir, in which he determined the explosive force necessary to detach a fragment from a planet with a velocity that would cause it to describe the orbit of a comet. He found that a fragment detached from the earth in this manner, with a velocity equal to 121 times that of a cannon-ball, would become a direct comet; and if with a velocity equal to 156 times that of a cannon-ball, its motion would be retrograde. For

other planets the velocity must be $\frac{121 \text{ or } 156}{\sqrt{\text{mean distance}}}$, and

consequently less as the mean distance of the planet from the sun is greater. A smaller velocity would be required to cause the detached fragment to move in an elliptic orbit; and with regard to the four small planets we are now considering, an explosive force less than twenty times that of a cannon-ball would have sufficed to detach them from a primitive planet, and cause them to describe ellipses similar to their actual orbits. This hypothesis served also to explain the great eccentricities and inclinations by which these planets are distinguished from the others belonging to the system; for it is evident that the explosive force must have projected the different fragments in all directions, and with different velocities. It followed also, that other fragments of the original planet might probably exist, revolving in orbits which, however they might differ in respect of inclination and eccentricity, would still intersect each other in the same points, or have common nodes, in which the several fragments would necessarily be found at each revolution. Dr Olbers therefore proposed to examine carefully every month the two opposite parts of the heavens in which the orbits of Ceres and Pallas intersect each other, with a view to the discovery of other planets, which might be sought for in those parts with greater chance of success than in a wider zone embracing the whole limits of their orbits. Subsequent discoveries demonstrated the soundness of his conjecture, and gave a degree of probability to his hypothesis.

According to Herschel, the diameter of Pallas is only about 80 English miles, or about one half of that which he assigned to Ceres, while Schroeter estimates it at 2099 miles. Schroeter also found the atmosphere of Pallas to be about two thirds of the height of that of Ceres, or about 450 miles. The light of the planet undergoes considerable variations, the cause of which is uncertain.

While M. Harding, of the observatory of Lilienthal, near Bremen, was engaged in forming a complete zodiac of the small telescopic stars near the orbits of Ceres and Pallas, with which these planets were likely to be confounded, he determined, on the 22d of September 1804, the position of a small star, by comparing it with the two stars marked 93 and 98 of Pisces in Bode's catalogue. These two stars are situated very near the equator, and at a small distance from one of the nodes of Ceres and Pallas, and exactly in that sort of *defilé* where, according to Dr Olbers, an observer would be certain of detecting in their passage the other fragments of the original planet of which Ceres and Pallas are parts. On the 4th the star was no longer in the same position, but had moved a little to the south-west. On the 5th and 6th M. Harding, by means of a circular micrometer, determined the rate of its motion to be 12' 42" in declination to the south, and 7' 30" in right ascension, retrograde, the interval between the observations being 24 hours 14 min. 12 sec. From this it was evident that the body belonged to the planetary system. It had then the appearance of a star between the eighth and ninth magnitudes. It was without any nebulosity, and of a whitish colour. A few days

Theoretical Astronomy. afterwards the elements of its orbit were computed by Gauss. This planet has received the name of Juno, and for its symbol ♄, the starry sceptre of the queen of Olympus.

Juno is distinguished from the other planets by the great eccentricity of her orbit, which is so considerable, that she describes that half of it which is bisected by the perihelion in about half the time which she employs to describe the other half. This planet is somewhat smaller than Ceres and Pallas, and, though free from nebulosity, must have, according to Schroeter's observations, an atmosphere of greater density than that of any of the old planets.

Discovery of Vesta. The success of M. Harding encouraged Dr Olbers to renew the plan of research which he had pointed out on the discovery of Pallas; and on the 29th of March 1807 he perceived, in the constellation of Virgo, a star of the fifth or sixth magnitude, which he suspected from the first observation to be a new planet. A few subsequent observations rendered this conjecture certain. Dr Olbers left to Gauss the care of giving a name to the new planet, and of determining the elements of its orbit. Gauss named it Vesta, and chose for its symbol ♃, an altar surmounted with a censer holding the sacred fire. Vesta is the smallest of all the celestial bodies known to us. Her volume is only about a fifteen thousandth part of that of the earth, and her surface is about equal to that of the kingdom of Spain. She is distinguished by the vivacity of her light, and the luminous atmosphere with which she is surrounded.

Jupiter.

Jupiter is by far the largest planet in the system. His diameter is about 11 times, and his volume 1281 times, greater than that of the earth. His distance from the sun is $5\frac{1}{2}$ times the radius of the ecliptic, or nearly 125,000 terrestrial semidiameters, and consequently above 490 millions of miles. His apparent diameter, which, at his mean distance, is $36''\cdot7$, and varies between $45''\cdot8$ and $30''$, would subtend an angle of $3' 17''$ if seen at the same distance as the sun. From Jupiter the sun will appear under an angle of $6'$ at most; the sun's disk will appear to be 27 times smaller than when seen from the earth, consequently the light and heat which Jupiter receives from the sun will be only the 27th part of what is received by our globe. His density is $\cdot99239$, that of the sun being considered as unity, or is about one fourth of the density of the earth; and a body which weighs one pound at the equator of the earth, would weigh $2\cdot444$ pounds if removed to the equator of Jupiter.

Belts of Jupiter. Plate LXXXVIII. Jupiter has the same general appearance with Mars, only the belts on his surface are much larger and more permanent. Their usual appearance, as described by Dr Long, is represented fig. 97-100; but they are not to be seen but by an excellent telescope. They are said to have been first discovered by Fontana and two other Italians, but Cassini was the first who gave a good account of them. Their number is very variable, as sometimes only one, but seldom more than three, may be perceived. Messier at one time saw so great a number that the whole disk seemed to be covered by them. They are generally parallel to one another, but not always so; and their breadth is likewise variable, one belt having been observed to grow narrow, while another in its neighbourhood has increased in breadth, as if the one had flowed into the other: and in this case a part of an oblique belt lay between them, as if to form a communication for this purpose. The time of their continuance is very uncertain: sometimes they remain unchanged for three months, at

Theoretical Astronomy. other times new belts have been formed in an hour or two. In some of these belts large black spots have appeared, which moved swiftly over the disk from east to west, and returned in a short time to the same place; whence the rotation of this planet about its axis has been determined. On the 9th of May 1664, Dr Hooke, with a twelve feet telescope, observed a small spot in the broadest of the three obscure belts of Jupiter; and observing it from time to time, found that in two hours it had moved from east to west about half the visible diameter of the planet. In 1665 Cassini observed a spot near the largest belt of Jupiter, which is most frequently seen. It appeared round, and moved with the greatest velocity when in the middle, but appeared narrower, and moved slower, the nearer it was to the circumference; showing that the spot adhered to the body of Jupiter, and was carried round upon it. This principal, or ancient spot as it is called, is the largest and the most permanent of any hitherto known; it appeared and vanished no fewer than eight times between the years 1665 and 1708: from the year last mentioned it was invisible till 1713. The longest time of its continuing to be visible was three years, and the longest time of its disappearing was from 1708 to 1713. It seems to have some connection with the principal southern belt; for the spot has never been seen when that disappeared, though the belt itself has often been visible without the spot. Besides this ancient spot, Cassini, in the year 1699, saw one of less stability, that did not continue of the same shape or dimensions, but broke into several small ones, whereof the revolution was but 9 hours 51 min.; and two other spots that revolved in 9 hours $52\frac{1}{2}$ min. The changes in the appearance of the spots, and the difference in the time of their rotation, make it probable that they do not adhere to Jupiter, but are clouds transported by the winds, with different velocities, in an atmosphere subject to violent agitations.

By means of the spots, which can be easily observed, the rotation of Jupiter has been determined with considerable precision. The time of rotation, according to Cassini, Maraldi, and others, is 9 hours and between 55 and 56 minutes: Schroeter makes it 9 hours 55 min. 33 sec. The inclination of his equator to his orbit is only $3^{\circ} 5' 30''$, so that the variations of his seasons must be almost insensible.

The radius of Jupiter being nearly 11 times ($10\cdot86$) that of our earth, and his rotation being $2\cdot4$ times more rapid, it follows that the space passed over by a point on his equator is 26 times greater than that passed over by a point of the terrestrial equator in the same time. Hence the centrifugal force is 26 times greater; and if the spheroidal form of the earth is occasioned by the diurnal motion, we may expect to find the same effects on a much larger scale exhibited in the form of Jupiter. And this is in fact observed to be the case; for the compression of Jupiter is about $\frac{1}{14}$ th of his radius, the diameter of his equator being to that of his poles as 15 to 14 nearly, while that of the earth is only $\frac{1}{303}$ th. According to Struve, the equatorial diameter at the mean distance subtends an angle of $38''\cdot327$, the polar $35''\cdot538$; and the

$$\text{ellipticity is } 0\cdot0728 = \frac{1}{13\cdot71}.$$

The annual parallax of Jupiter is less than 12° , consequently the earth, as seen from Jupiter, will never appear at a greater distance than 11° or 12° from the sun. The digressions of Mars would be $17^{\circ} 2'$, those of Venus 8° , and those of Mercury only $4^{\circ} 16'$. An inhabitant of Jupiter must therefore be probably ignorant of the existence of Mercury, which will be almost constantly plunged in

Theoretical Astronomy. the sun's rays, and likewise greatly diminished in splendour, on account of his great distance. From this we may infer the possibility of the existence of planets inferior to Mercury, and invisible to us, for similar reasons.

Satellites of Jupiter.

On observing Jupiter through the telescope, he is seen accompanied by four little stars, which oscillate on both sides of him, and follow him in his orbit as the moon follows the earth. On this account they are called *satellites* or attendants. They were first noticed by Galileo within a year after the discovery of the telescope; and it was soon perceived that they revolve around Jupiter in narrow circles, the planes of which deviate little from that of the equator of the planet. They are distinguished from one another by the denomination of *first*, *second*, *third*, and *fourth*, according to their relative distances from Jupiter, the *first* being that which is nearest to him. Their apparent motion is oscillatory, like that of a pendulum, going alternately from their greatest elongation on one side to their greatest elongation on the other, sometimes in a straight line and sometimes in an elliptic curve, according to the different points of view in which we observe them from the earth. They have also their stations and retrogradations, and exhibit in miniature all the phenomena of the planetary system.

Occultations and eclipses of the satellites.

Since the satellites revolve in orbits about the huge orb of Jupiter, it is evident that occultations of them must frequently happen, by their going behind their primary, or by coming in between us and it; in the former case when they proceed towards the middle of their upper semicircle, and in the latter when they pass through the same part of their inferior semicircle. Occultations of the former kind happen to the first and second satellites at every revolution; the third very rarely escapes an occultation; but the fourth more frequently, by reason of its greater distance. It is seldom that a satellite can be discovered upon the disk of Jupiter, even by the best telescopes, excepting at its first entrance, when, by reason of its being more directly illuminated by the rays of the sun than the planet itself, it appears like a lucid spot upon it. Sometimes, however, a satellite in passing over the disk appears like a dark spot, and can be easily distinguished. This is supposed to be owing to spots on the body of these secondary planets; and it is remarkable that the same satellite has been known to pass over the disk at one time as a dark spot, and at another appearing so luminous that it could not be distinguished from Jupiter himself, except at its coming on and going off. To account for this diversity of appearance, we must suppose either that the spots are subject to change, or, if they be permanent, like those of our moon, that the different portions of the surfaces of the satellites are not equally luminous, and that at different times they turn different parts of their globes towards us. Possibly both these causes may contribute to produce the phenomena just mentioned. By reason of the spots, also, both the light and apparent magnitude of the satellites are variable; for the fewer spots there are upon that side which is turned towards us, the brighter it will appear; and as the bright parts only can be seen, a satellite must appear larger the more of its bright side it turns towards the earth, and smaller the more it happens to be covered with spots. The fourth satellite, though generally the smallest, sometimes appears larger than any of the rest. The third sometimes seems least, though usually the largest; nay, a satellite may be so covered with spots as to appear less than its shadow passing over the disk of the primary, though we are certain that the shadow must be smaller than the body from which it is projected. To a spectator placed on the surface of Jupiter, each of these satellites would put on the phases of the moon; but as the distance of any

Theoretical Astronomy. of them from Jupiter is but small when compared with the distance of that planet from the sun, the satellites are illuminated by the sun very nearly in the same manner with the primary itself; hence they appear to us always round, having constantly the greater part of their enlightened half turned towards the earth; and, indeed, on account of their small size, their phases can scarcely be discerned even through the best telescopes. Their spots, or rather the observed variations of their brilliancy at different times, have afforded the means of determining the fact and the period of their rotation; and it is a very remarkable circumstance that they all, like the moon, constantly turn the same face towards their primary, or complete a rotation about their respective axes in the same time in which they perform a revolution in their orbits.

When the satellites pass through their inferior semicircles, they may cast a shadow upon their primary, and thus cause an eclipse of the sun; and in some situations this shadow may be observed going before or following the satellite. On the other hand, in passing through their superior semicircles, the satellites may be eclipsed in the same manner as our moon, by passing through the shadow of Jupiter. And this is actually the case with the first, second, and third of these bodies; but the fourth, by reason of the greater magnitude and inclination of its orbit, passes sometimes above or below the shadow, as is the case with the moon. The beginnings and endings of these eclipses are easily seen through the telescope, when Jupiter is at a sufficient distance from the sun. The same satellite disappears at different distances from the planet, according to the relative situations of Jupiter, the sun, and the earth; but always on that side of the disk where the shadow of the planet is known from computation to be. With regard to the first and second satellites, the immersions only are visible while Jupiter is passing from his conjunction to his opposition with the sun, and the emersions while he passes from his opposition to his conjunction. The third and fourth sometimes disappear, and again appear on the same side of the disk; and the time during which the satellite continues invisible is exactly that in which, according to computation, it would pass through the planet's shadow. When Jupiter is near his opposition, the eclipses take place when the satellites are close to his disk; because the eye of the spectator is then nearly in the axis of the dark cone formed by his shadow.

These various phenomena will be better understood by referring to fig. 101, where A, B, C, D, represent the earth in different parts of its orbit; J Jupiter in his orbit MN, surrounded by his four satellites, the orbits of which are marked 1, 2, 3, 4. At *a* the first satellite enters the shadow of the planet; at *b* it emerges from it, and advances to its greatest eastern elongation at *c*. It appears to pass over the disk of Jupiter like a dark spot at *d*, and attains its greatest western elongation at *e*. Similar phenomena take place with respect to the other satellites. Now, since the shadow of Jupiter is always directed away from the sun, the immersions only will be visible to the earth when the earth passes from the position C to the position A; for the eastern limit of Jupiter conceals the satellite at the time of emersion, as is evident by drawing *fg* in the direction of the visual ray. For the same reason the emersions only are visible while the earth is passing from A to C, or when Jupiter advances from his opposition to his conjunction. This, however, is only strictly true of the first satellite; for the third and fourth, as we have already remarked, and sometimes even the second, owing to their greater distances from Jupiter, occasionally disappear and re-appear on the same side of the disk.

The disks of the satellites having no sensible magni-

Theoretical Astronomy. Dimensions of the satellites. tude except in the very best telescopes, their diameters have only recently been determined by direct measurement. Schroeter and Harding attempted to measure them by observing the time which the satellite takes to pass over the disk of Jupiter; but such observations are liable to great uncertainty, by reason of differences in the magnifying power of the telescopes, the sight of the observer, the state of the atmosphere, the distance of the satellites from the primary, their altitude above the horizon, and even on account that, by reason of their rotation, they do not always present to us the same hemisphere. Schroeter estimates their diameters relatively to Jupiter as follows:—That of the first = $\frac{1}{34}$, of the second = $\frac{1}{42}$, of the third = $\frac{1}{24}$, of the fourth = $\frac{1}{24}$. The following are the results of a series of micrometrical measurements made by Professor Struve at the Dorpat observatory, with the great refractor of Fraunhofer:—

Diameter of the first.....	1".015
Diameter of the second.....	0.911
Diameter of the third.....	1.488
Diameter of the fourth.....	1.273

These dimensions are adapted to the mean distance of Jupiter, namely 5.20279. Compared with the earth, the diameters of the satellites are approximately as follows:—I. = $\frac{1}{3}$, II. = $\frac{1}{4}$, III. = $\frac{1}{2}$, IV. = $\frac{1}{3}$. As seen from Jupiter, the apparent magnitude of the first will be nearly equal to that of our moon seen from the earth; the second and third somewhat greater than half; and the fourth nearly equal to a quarter of that of the moon. These four moons must present to the inhabitants of Jupiter a spectacle of endless variety, on account of the rapid rotation of the planet, the short period of their revolutions, and their eclipses, which happen almost daily.

Saturn.

Saturn, the remotest of the planets known to the ancient astronomers, circulates round the sun at a distance equal to about $9\frac{1}{2}$ times the semidiameter of the terrestrial orbit, or nearly 900 millions of miles. His apparent diameter at his mean distance is only about $16''\cdot2$, yet his true diameter is nearly 10 times, and his volume about 995 times, that of our globe. The area of the sun's disk, as seen from Saturn, is only $\frac{1}{80}$ of its apparent magnitude as seen from the earth; consequently the light and heat which any point on his surface receives from the great luminary is 80 times less than that which we enjoy. His density, compared with that of the sun considered as unity, is supposed to be .55, or about $\frac{1}{2}$ of the density of the earth; and a body which weighs one pound at the equator of the earth, would weigh about 1.01 pound if transferred to the equator of Saturn.

Ring of Saturn.

This planet, in consequence of a luminous double ring with which he is surrounded, presents one of the most curious phenomena in the heavens. This singular appendage was first noticed by Galileo, to whom the planet presented a *triple* appearance, the large orb being situated between two small bodies or *ansæ*. Sometimes the ansæ are so enlarged as to present the appearance of a continuous ring; at other times they entirely disappear, and Saturn appears round like the rest of the planets. After a certain time they again become visible, and gradually increase in magnitude; and they evidently do not adhere to the surface of the planet, inasmuch as a vacant space between them is distinctly perceived even in ordinary telescopes.

These curious appearances were shown by Huygens to be occasioned by an opaque, thin, circular ring, surrounding the equator of Saturn, and at a considerable distance from the planet. Saturn moving in the plane of his orbit

Theoretical Astronomy. carries the ring along with him, which, presenting itself to the earth under different inclinations, occasions all the phenomena which have been described. The ring being only luminous in consequence of its reflecting the solar light, it is evident that it can be visible only when the sun and the earth are both on the same side of it: if they are on opposite sides it will be invisible. It will likewise be invisible in two other cases, namely, 1st, when its plane produced passes through the centre of the earth, for then none of the light reflected from it can reach us; and, 2d, when its plane passes through the sun, because its edge is then only enlightened; and being very thin, the whole quantity of reflected light will scarcely be sufficient to render it visible. It is, however, evident that in these two cases the effect will be modified in some degree by the power of the telescope. In ordinary telescopes the ring disappears sometimes before its plane comes into either of the situations mentioned; but Herschel never lost sight of it, either when its plane passed through the earth or the sun. In the last case the edge of the ring appeared as a luminous line on the round disk of the planet, measuring scarcely a second in breadth; but at the distance of Saturn a second corresponds to 4000 miles, which is equal to the semidiameter of the terrestrial globe. The reason of the ring's disappearance will be easily understood by referring to fig. 102, where the circle *a b c d* represents the orbit of the earth, A B C D that of Saturn $9\frac{1}{2}$ times more distant from the sun. When Saturn is at A, the earth and sun are both in the plane of the ring; its edge is consequently turned towards us, and it will be invisible unless telescopes of very high power are used. As Saturn advances from A to B the ring gradually opens, and it attains its greatest breadth at C, where its face is turned more directly towards us, or a straight line perpendicular to its plane makes a more acute angle with the visual ray than in any other situation. As the planet advances towards D, the plane of the ring becomes more oblique to the visual ray; the breadth of the ring consequently contracts, and it again disappears at E. From E to F, G, and A, the same phenomena will be repeated, only in this case it is the southern side of the ring which is visible to the earth, whereas, while Saturn was in the other half of his orbit, it was the northern side.

The successive disappearances of the ring form a period of about 15 years, with some variations arising from the different positions of the earth in its orbit. At present (1830) the south side is presented to us; it will be invisible in 1833; its northern side will become visible in 1838; it will again disappear in 1847, and show its southern side in 1855.

Sir W. Herschel's observations have added greatly to our knowledge of Saturn's ring. According to him, the ring is separated into two annular portions by a dark belt or zone, which he has constantly found on the north side. As this dark belt is subject to no change whatever, it is probably owing to some permanent construction of the surface of the ring; and it is evidently contained between two concentric circles, for all the phenomena correspond with the projection of a circular zone. The matter of the ring Herschel thinks no less solid than that of Saturn, and it is observed to cast a strong shadow upon the planet. The light of the ring is also generally brighter than that of the planet; for it appears sufficiently luminous when the telescope affords scarcely light enough for Saturn. It is remarkable that the outer ring is much less brilliant than the inner. Herschel concludes that the edge of the ring is not flat, but spherical or spheroidal. The dimensions of the ring, or of the two rings with the space between them, he gives as follows:—

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	Miles.
Inner diameter of smaller ring.....	146345
Outside diameter of ditto.....	184393
Inner diameter of larger ring.....	190248
Outside diameter of ditto.....	204883
Breadth of the inner ring.....	20000
Breadth of the outer ring.....	7200
Breadth of the vacant space, or dark zone.....	2839
The following measures were taken by Professor Struve, at Dorpat in Russia, in 1828, with a repeating wire-micrometer attached to the large refracting telescope of Fraunhofer, belonging to the observatory at that place, and may be regarded as decidedly the most accurate of any that we possess. (See <i>Memoirs of the Astronomical Society</i> , vol. iii. p. 301.)	
Outer diameter of the outer ring.....	40"·095
Inner diameter of the outer ring.....	35"·289
Outer diameter of the inner ring.....	34"·475
Inner diameter of the inner ring.....	26"·668
Breadth of the outer ring.....	2"·403
Breadth of the division between the rings.....	0"·408
Breadth of the inner ring.....	3"·903
Distance of the ring from the ball.....	4"·339
Equatorial diameter of Saturn.....	17"·991

These dimensions are adapted to the mean distance of Saturn, 9·53877. According to the same excellent astronomer, the inclination of the plane of the ring to the ecliptic is $28^{\circ} 5' 9''$.

In observing the ring with very powerful telescopes, some astronomers have remarked, not one only, but several dark concentric lines on its surface, which divide it into as many distinct circumferences. In common telescopes these are not perceptible; for the irradiation, by enlarging the space occupied by each ring, causes the intervals between them to disappear, and the whole seems blended together in one belt of uniform appearance. (See fig. 103.) Struve, however, noticed no trace of the division of the ring into many parts.

By means of some spots observed on the surface of the ring, Herschel found that it revolves in its own plane in 10 hours 32 minutes 15·4 seconds; and Laplace arrived at the same result from theory. It is particularly worthy of remark, that this is the period in which a satellite, having for its orbit the mean circumference of the ring, would complete its revolution according to the third law of Kepler. This circumstance furnishes a physical explanation of the reason why the ring is able to maintain itself about the planet without touching it; or at least brings the fact within the general law by which the planets are sustained in their orbits. The centrifugal force resulting from its rotation, and the attraction of the planet, suffice to maintain its equilibrium.

From observations of some obscure belts, and a very conspicuous spot on the surface of Saturn, Herschel concluded that his rotation is performed in 10 hours 16 minutes, on an axis perpendicular to the belts and to the plane of the ring; so that the planes of the planet's equator and ring coincide. According to the same astronomer, the ratio of the equatorial and polar diameters of Saturn is 2281 to 2061, or nearly 11 to 10. But it is very remarkable that the globe of Saturn appears to be flattened at the equator as well as at the poles. The polar compression extends to a great distance over the surface of the planet, and the greatest diameter is that of the parallel of 43° of latitude, where, consequently, the curvature of the meridians is also the greatest. The disk of Saturn, therefore, resembles a square of which the four corners have been rounded off. According to the latest observations of Herschel, the axis of rotation, the diameter of the

equator, and the greatest diameter under the parallel of 43° , are to one another as the numbers 32, 35, 36. (See the *Philosophical Transactions* for 1806, Part II.)

Saturn is attended by seven satellites, but so small that they can only be seen by the help of powerful telescopes. Huygens first discovered one of these satellites in 1655. It is the sixth in the order of distance, and is the largest of them all. Four others were discovered about twenty years afterwards by Dominic Cassini; and, lastly, Sir W. Herschel, in 1789, discovered two new satellites, at a time when the ring was visible only in a telescope of forty feet. The orbits of these are interior to those of the five satellites formerly discovered, but exterior to the ring, though so near to it that it is only when the ring disappears that they can be seen. All the satellites appear to revolve in the plane of the ring, with the exception of the two last. The inclinations of their orbits are, however, not known with much certainty.

Uranus.

Uranus is the remotest planet belonging to the system, and is scarcely visible excepting through the telescope. His distance from the sun is nineteen times the radius of the ecliptic, or about 1800 millions of miles; and his sidereal revolution is performed in 83 years 150 days and 18 hours. His diameter is about 35,112 English miles, or nearly six and a half times that of the earth, and, seen from the earth, subtends an angle of only $4''$, even at the time of his opposition. The apparent diameter of the sun, seen from this planet, is $1' 40''$; consequently the surface of the sun will there appear 400 times less than it does to us, and the light and heat which is received will be less in the same proportion. Analogy leads us to infer that Uranus is opaque and revolves on his axis, but of this there is no direct proof. Laplace has concluded from theory, that the time of his diurnal rotation cannot be much less than that of Jupiter and Saturn, and that the inclination of his equator to the ecliptic is very inconsiderable. His density is supposed to exceed somewhat that of the earth. Schroeter thinks that certain variations in the appearances of his disk indicate that great changes are going on in his atmosphere.

This planet was discovered by Sir W. Herschel at Bath on the 13th of March 1781. His attention was attracted to it by the largeness of its disk in the telescope, which exceeded that of stars of the first magnitude, while to the naked eye it appeared only as a star of the seventh magnitude. In the course of a few days its proper motion became sensible, consequently it could not be a fixed star. Herschel at first took it for a comet, but it was soon perceived that it described a path which, instead of resembling the eccentric orbits of the comets, was almost circular, like that of the planets. It was then recognised to be one of the principal planets of the solar system; and the observations of the last fifty years have not only confirmed this fact, but afforded data from which the elements of its orbit have been determined with great precision. Herschel gave it the name of the *Georgium Sidus*, in honour of his royal patron George III. Foreigners for some time generally called it the *Herschel*, after its discoverer; but the mythological name of *Uranus*, suggested by the late Professor Bode of Berlin, is now generally adopted. In 1787 Herschel discovered that it was attended by two satellites: he subsequently discovered four others, so that Uranus is accompanied by six satellites; and the whole number of satellites now known to belong to the system is consequently eighteen.

Before concluding this section, it will be proper to take notice of the following curious relation of the numbers

Rotation
of the
ring.Rotation
of Saturn.

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Let the number 10 be assumed to represent the semidiameter of the earth's orbit; then the semidiameters of the orbits of the other planets may be expressed in round numbers as follows:—

Mercury...	4
Venus.....	$7 = 4 + 3 \cdot 2^0$
Earth.....	$10 = 4 + 3 \cdot 2^1$
Mars.....	$16 = 4 + 3 \cdot 2^2$
Ceres.....	$28 = 4 + 3 \cdot 2^3$
Jupiter...	$52 = 4 + 3 \cdot 2^4$
Saturn...	$100 = 4 + 3 \cdot 2^5$
Uranus...	$196 = 4 + 3 \cdot 2^6$

It will be remarked that every succeeding term of this series of numbers, after the second, is the double of the preceding, minus 4; the general term being $4 + 3 \cdot 2^{n-2}$, commencing with Venus, and n indicating the rank of the planet.

A view of the proportional magnitudes of the orbits and disks of the planets, as also of the comparative magnitudes of the sun seen from each planet, is given in fig. 104.

On the subjects contained in this section the following works may be consulted: Galileo, *Nuntius Sidereus*; Simon Marius, *Mundus Jovialis anno 1609 detectus*, &c. 1614; Cassini, *Martis circa proprium axem revolvibilis Observationes Bononienses*, Bonon. 1666; Idem, *Disceptatio Apologetica de Maculis Jovis et Martis*, Bonon. 1667; Idem, *Nouvelles Découvertes dans le Globe de Jupiter*, Paris, 1690; Bianchini, *Hesperii et Phosphori Nova Phænomena*, 1728; Cassini, *Elemens d'Astronomie*, 1740; Schroeter, *Aphroditographische Fragmente*, Helmstadt, 1796; Idem, *Lilienthalische Beobachtungen der neu entdeckten planeten*, Göttingen, 1805; Gauss, *Theoria Motus Corporum Cælestium*, Hamburgi, 1801; Idem, *Journal of Gotha*, 1811; Laplace, *Mécanique Céleste*, tome iv. p. 135; Idem, *Système du Monde*; Delambre, *Astronomie*, tome ii. chap. xxvii.; Schubert, *Traité d'Astronomie Théorique*, tome ii. Petersburg, 1822; and the numerous papers of Sir W. Herschel in the *Philosophical Transactions*.

SECT. IV.—Of the Orbits of the Satellites.

In order to establish a theory of the motions of the satellites, the first thing necessary is to ascertain the directions in which they move with reference to the primary planet. Now, it is observed that their motion is sometimes towards the east, and at other times towards the west; but that the satellites are never eclipsed except in passing from the west to the east of the planet. When an eclipse takes place the satellite is always moving eastward; on the other hand, the satellite is always moving westward when it appears on the planet's disk. From this it results that the true motions of the satellites around the planets are from west to east, according to the order of the signs, or in the same directions as the motions of the planets about the sun. This fact, which holds true of the moon, and the satellites of Jupiter and Saturn, is one of the most remarkable in the planetary system. With regard to the satellites of Uranus, their motions are performed in orbits almost perpendicular to the ecliptic; they cannot therefore with propriety be said to be either direct or retrograde.

The eclipses of the satellites of Jupiter present an easy

Theoretical Astronomy. method of determining their mean motions and periodic times; and, by reason of the small inclinations of the orbits, these are of very frequent occurrence; for the first three satellites traverse the shadow of Jupiter in every revolution, and the fourth only passes by it sometimes, in consequence of the greater inclination of its orbit. If the instants can be observed at which a satellite enters and emerges from the shadow, the middle point of time between these two instants will be that of the heliocentric conjunction of the satellite with its primary. The interval between two central eclipses gives the *synodic period* of the satellite; whence, since the motion of the primary is known, the *sidereal period* of the satellite, and its mean angular motion with regard to the straight line joining the centres of the sun and the planet, are easily deduced. Instead of two successive eclipses, it is preferable to compare two that are separated from each other by a long interval of time; the interval divided by the number of sidereal revolutions will give the mean time, unaffected by any periodic inequalities which may exist in consequence of the mutual action of the satellites on one another. In order to render the result as accurate as possible, those eclipses are chosen which take place when the planet is nearly in opposition.

The distances of the satellites from their primary are ascertained by measurement with the micrometer, at the time of the greatest elongations. On comparing the distances with the times of revolution, the beautiful law of Kepler is found to prevail; and, as in the system of the planets, so in the various systems of the satellites, the squares of the periodic times vary as the cubes of the mean distances from the central body. The distances of the satellites of Jupiter and Saturn, compared with the diameters of their respective primaries, are represented in fig. 105.

The inclinations of the orbits of the satellites of Jupiter, and the positions of their nodes, together with the other elements of their elliptic motion, are determined by means of their eclipses. The plane of the orbit of the first satellite nearly coincides with the plane of the equator of Jupiter, the inclination of which to the plane of his orbit is $3^\circ 5' 30''$. The inclination of the orbit of the second to the plane of the planet's equator is $27' 49'' \cdot 2$. Its nodes have a retrograde motion on that plane, and go through an entire circuit in the space of 30 years. The orbit of the third is inclined to the equator of Jupiter in an angle of $12' 20''$; and the line of the nodes retrogrades through a whole circumference in 142 tropical years. Hence the inclinations of the orbits of these two satellites to the orbit of Jupiter are variable; that of the second varying between $3^\circ 19' 24'' \cdot 6$ and $2^\circ 51' 35'' \cdot 4$, and that of the third between $3^\circ 17' 50''$ and $2^\circ 53' 10''$. The inclination of the orbit of the fourth satellite to the orbit of Jupiter is also variable. Its nodes have a retrograde motion, and complete a revolution in 531 years. Since the middle of the last century the inclination of this satellite has been observed to increase, and the motion of its nodes to diminish. (Laplace, *Mécanique Céleste*, tome iv. livre viii.)

The orbits of the four satellites are doubtless elliptical, but those of the first and second are so small that it has been found impossible to determine their eccentricity. The eccentricity of the third is perceptible, that of the fourth much more so. According to Laplace, the greatest equation of the centre of the third, at its maximum in 1682, amounted to $13' 16'' \cdot 4$, and at its minimum in 1777, only to $5' 7'' \cdot 5$. The eccentricity of the orbit of the fourth is still greater, and also subject to considerable variations. The line of the apsides has a direct motion, amounting to $42' 58'' \cdot 7$ annually. The great in-

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fluence of the compressed figure of Jupiter on these elements gives each of the orbits an eccentricity peculiar to it; but each also participates in the eccentricities of the others. The mutual perturbations of the satellites greatly affect their motions, and render their analytical theory exceedingly complicated and difficult.

On comparing the mean longitudes with the mean motions of the first three satellites of Jupiter, Laplace discovered the two following relations, which, by reason of their remarkable simplicity, may perhaps be regarded as among the most curious discoveries ever made in astronomy. Denoting by m' , m'' , m''' , the mean motions of the three satellites respectively, and their mean longitudes by l , l' , l'' , these laws are expressed by the formulæ,

$$\begin{aligned} m' + 2m'' - 3m''' &= 0 \\ l + 2l'' - 3l' &= 180^\circ; \end{aligned}$$

that is to say, the mean sidereal motion of the first, added to twice that of the third, is equal to three times that of the second; and the mean longitude of the first satellite, plus twice that of the third, minus three times that of the second, is always equal to a semicircumference. The first of these relations is true of the synodical as well as of the sidereal revolutions; and it follows from the second, that the first three satellites can never be eclipsed at the same time, because in that case their longitudes would be equal, or $l + 2l'' - 3l' = 0$. These results of theory agree so nearly with observation, that we are tempted to regard them as rigorously exact, and to ascribe the slight differences that may be perceptible to the unavoidable errors of observation, and to the periodic inequalities in the motions of the satellites, by reason of which their true motions are alternately greater and smaller than their mean motions. We must therefore infer that these relations depend on a physical cause, by which they will be preserved for ever, or at least during a long series of ages, notwithstanding the small oscillations to which, from various sources of perturbation, the mean longitudes of the satellites are subject.

From observations of the eclipses of Jupiter's satellites, Roemer was led to the very important discovery of the successive propagation of light. The times at which these eclipses happen are found to differ from the times computed from the sidereal revolutions of the satellites, being sometimes earlier and sometimes later, according to the position of Jupiter relatively to the sun and the earth. When Jupiter is in opposition with the sun, and his distance from the earth consequently less than his distance from the sun by the whole radius of the earth's orbit, the satellites are eclipsed sooner than they ought to be according to computation. On the contrary, when Jupiter is in conjunction, and his distance from the earth greater than his distance from the sun by the same quantity, the eclipses happen later. These differences, which are exactly the same for all the satellites, cannot be ascribed either to the eccentricity of the orbit of Jupiter, or to inequalities in their motion; for the oppositions and conjunctions of the planet correspond successively to all the different points of his orbit, and the eclipses also happen when the satellite is at different points of its own orbit. The simplest and most natural way of explaining the phenomenon is to suppose that the light reflected from the satellites is not transmitted to the earth instantaneously, but occupies a sensible portion of time in traversing the diameter of the terrestrial orbit. When Jupiter is near his conjunction, the eclipses are observed to happen about 16 minutes 26 seconds later than when he is near his opposition; the difference between his distances from the earth in these two positions is equal to the diameter of the earth's orbit, supposing the orbits to be circular: it follows, there-

fore, that light employs 16 minutes 26 seconds in traversing the terrestrial orbit, and consequently the half of that time, or 8 minutes 13 seconds, in coming from the sun to the earth. The exact agreement of this hypothesis with observation renders its truth unquestionable. The fact of the successive transmission of light led to another discovery of the utmost importance in astronomy, namely, the aberration.

The eclipses of Jupiter's satellites are useful in determining the longitude of places on the earth, and on this account the theory of the motions of these bodies has been cultivated with the most laborious care. The epochs at which the eclipses take place are calculated in advance, and inserted in the *Ephemerides*. On comparing these epochs, computed for a given meridian, with the immediate results of observation made in another place at a given hour, the difference of time is obtained, whence the difference of longitude is immediately deduced. The method is the same as for the eclipses of the moon. Unfortunately, by reason of the magnifying power required to render the satellites visible, it cannot be employed at sea, the instability of the vessel rendering the telescopes unserviceable. The tables of Delambre, which were computed from the theory of Laplace, and the comparison of an immense number of observations, give the places of the satellites with all the precision which it is perhaps possible to obtain.

The satellites of Saturn have not the practical utility of those of Jupiter, because, by reason of their great distance, their eclipses are invisible; and indeed some of them cannot be perceived at all, excepting through telescopes of extraordinary power. Their periods, mean motions, and some of the other elements of their orbits, are determined by the micrometrical measurement of their greatest digressions from their primary. At the time of their greatest digressions they are always situated in the same straight line with the greater axis of the ring, and their distances from Saturn are then equal to the semi-transverse axes of their apparent orbits. In their conjunctions the minor axes of their apparent ellipses seem only half as great as their transverse axes, whence it is inferred that the sine of their inclination is one half, and consequently that the inclination itself is about 30° , which is nearly the inclination of the ring. Hence the satellites seem to move in the plane of the ring. The only one which deviates considerably from that plane is the seventh. From certain observations made by Bernard in 1787, Lalande makes the inclination of this satellite $22^\circ 42'$ to the orbit of Saturn, or $24^\circ 45'$ to the ecliptic. There exists, however, considerable uncertainty with regard to the inclination of the orbits of the satellites, as well as with regard to that of the ring.

According to the theory of Laplace, the spheroidal figure of Saturn must maintain the ring, and the orbits of the interior satellites, in the plane of his equator. But the amount of the compression is unknown: all that is certain is, that the inclination of the orbits of the first five satellites to the equator of the planet is insensible at the distance of the earth; consequently all the satellites, excepting the seventh, and probably also the sixth, will appear, as well as the ring, to move in the plane of the equator. The orbit of the seventh satellite preserves the same mean inclination to the plane of the equator of the planet; and the line of its nodes has a retrograde motion nearly uniform.

The orbit of the sixth satellite is elliptical. For the meridian of Paris its longitude in 1800 was $67^\circ 25' 47''$; that of its inferior apside $203^\circ 35' 7''$. Its mean motion in 36525 days is 2290 revolutions $+ 202^\circ 12'$; in one day

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Theoretical Astronomy. 22° 34' 37"-186. The eccentricity is .04887; and its greatest equation 5° 36' 8". By particular observations on this satellite, Bessel found its inclination to the ecliptic to be 24° 30', or 25° 55'; differing very sensibly from that of the ring or the equator of the planet. It is, however, not improbable that these two planes may have some inclination to each other. (Delambre, *Astronomie Théorique et Pratique*, tome iii. p. 510.)

The satellites of Uranus can be perceived with still greater difficulty than those of Saturn. The orbits of these satellites are almost perpendicular to the ecliptic. The elements of the second and fourth have been determined by actual measurement; the periods of the two others have been theoretically deduced from the third law of Kepler. The inclination of the fourth is 89° 30', or 90° 30', and the ascending node 171° or 249°, according as it is conceived to be direct or retrograde.

The following table exhibits the mean distances and sidereal revolutions of the satellites of Jupiter, Saturn, and Uranus.

MEAN DISTANCES. (The radius of the planet being = 1.)		SIDEREAL REVOLUTIONS,	
		According to Laplace.	According to Delambre.
Jupiter.		Days.	d. h. m. s.
1st satellite	5.81296	1.7691378	1 18 28 35.94537
2d.....	9.24868	3.5511810	3 13 17 55.73010
3d.....	14.75240	7.1545528	7 3 59 35.82511
4th.....	25.94686	16.6887697	16 18 5 7.02098
Saturn.		Days.	d. h. m. s.
1st satellite	3.080	0.94271	0 22 37 32.9
2d.....	3.952	1.37024	1 8 53 8.9
3d.....	4.893	1.88780	1 21 18 26.2
4th.....	6.268	2.73948	2 17 44 51.2
5th.....	8.754	4.51749	4 12 25 11.1
6th.....	20.295	15.94530	15 22 41 13.1
7th.....	59.154	79.32960	79 7 53 42.8
Uranus.		Days.	d. h. m. s.
1st satellite	13.120	5.8926	5 21 25 0.
2d.....	17.022	8.7068	8 17 1 19.
3d.....	19.845	10.9611	10 23 4
4th.....	22.752	13.4559	11 11 5 1.5
5th.....	45.507	38.0750	38 1 49
6th.....	91.008	107.6944	107 16 40

CHAP. V.

OF COMETS.

The comets form a class of bodies belonging to the solar system, distinguished from the planets by their physical appearances and the great eccentricity of their orbits. By reason of the smallness of their diameters, and a nebulosity which renders them ill adapted to reflect the rays of light, the greater part of them are only visible in the telescope, and continue to be so only during a short period of time; for as they advance to and recede from the sun almost in straight lines, and with prodigious velocities, they are soon carried far beyond the limits of vision. They have received the name of comets (*coma*, hair) from the *bearded* appearance which they frequently exhibit.

SECT. I.—Of the Orbits of Comets.

The comets are not more remarkably contrasted with the planets in the singularity of their physical appearances, than in the directions of the paths which they follow

in space. While the orbits of all the planets are confined within a narrow zone, or to planes not greatly inclined to the ecliptic, those of the comets are inclined in all possible angles, and some of them are even observed to be perpendicular to the ecliptic. Nor is the contrast less striking with regard to the figures of the orbits, which, instead of being nearly circular, like those of the planets, have the appearance of being almost rectilinear. Kepler was of opinion that the cometary orbits are straight lines; Cassini supposed them to be very eccentric circles; and Tycho was for some time of the same opinion, but he afterwards found that the hypothesis of the eccentric circle would not satisfy the observations of the comet of 1577. Hevelius seems to have been the first who discovered, by means of a geometrical construction, that the orbits might be represented by parabolas; and Dörfel first calculated their elements on this hypothesis. After it was known, however, that certain comets return to the sun in the same orbits, it became necessary to adopt an opinion, already probable from analogy, that, in conformity with the laws of Kepler, the cometary orbits are ellipses having the sun in one of the foci. This hypothesis is now universally admitted; but as the ellipses are in general extremely elongated, and the comets are only visible while they describe a small portion of their orbits on either side of their perihelia, their paths during the time of their appearance differ very little from parabolas; whence it is usual, on account of the facility of computation, to assume that they really move in parabolic curves. Newton employed the hypothesis of an elliptic motion to compute the orbit of the famous comet of 1680. Since that time the orbits of more than a hundred and fifty different comets have been computed on the elliptic hypothesis, and their elements determined so as to satisfy all the observations. It is possible that the orbits of some comets may be in reality parabolic; but in this case the comet, after having passed its perihelion, would recede to an infinite distance from the sun, and never again visit our system. Burckhardt imagined that the observations of the comet of 1771 were best represented by supposing the orbit to be an hyperbola. In fact, it is demonstrated in the *Principia*, and every treatise on Physical Astronomy, that the species of curve which one body describes about another, in virtue of an attractive force varying inversely as the square of the distance, depends only on its velocity of projection. The curve must necessarily be a conic section; but it may be an ellipse, a parabola, or an hyperbola, according as the primitive impulsive force falls within or exceeds certain assignable limits.

If the comets moved in parabolas or hyperbolas, and had consequently only a temporary connection with the solar system, the determination of their orbits would be a matter of mere curiosity, and of no consequence whatever to astronomy. But it is only by the accurate determination of the elements of their orbits that it can be discovered whether those bodies ever revisit the system; for the appearances which they exhibit, depending on the situation of the earth in its orbit with relation to them at the time they are visible, are far too variable and uncertain to afford any sure means of recognising them. The comet of 1811 was scarcely visible in the months of April and May; it was subsequently lost in the sun's rays, and, having passed its perihelion, reappeared in August with a splendour and magnificence that rendered it an object of admiration. It is therefore only by observing that a comet follows the same orbit in its successive returns to the sun that we can be assured of its identity. But even the determination of the orbit is not always sufficient to lead to the detection of a comet in a

Theoretical subsequent revolution; for if, in the course of the previous one, it came within the sphere of attraction of Jupiter, or any of the larger planets, the elements of its orbit may have been greatly or entirely changed. The orbit of the comet of 1770 was calculated by Lexell, and subsequently by Burckhardt, and both these astronomers found that the observations could only be represented by an ellipse in which the time of revolution was five years and a half; yet the comet has never been seen since, or at least seen moving in the same orbit. Hence it is concluded with certainty that the attraction of Jupiter, near which planet it approached, was so great as to compel it to move in a totally different ellipse. Other causes also conspire to render the chances of the discovery of periodic comets extremely small. In the first place, it is only within a very small portion of their orbits that they are visible; and this, on account of its proximity to the sun, is passed over with inconceivable rapidity. But in proportion as they recede from their perihelia the solar action diminishes; and, towards the aphelion of its orbit, a comet may be almost motionless, and for this reason not return for thousands of years. In the second place, it may happen, that during the greater part of the time the comet continues in the visible portion of its orbit, it may rise above the horizon only during the day, in which case it will be invisible, and may consequently pass through our system without being observed. The comet of 1818 was present in all its splendour long before it became visible, but in full day. Seneca relates a very curious instance of one having been seen during a total eclipse of the sun, in the year 60 before our era. A third cause of uncertainty consists in the difficulty of observing their true places with sufficient precision to enable the elements of their orbits to be exactly determined. The small comets are only nebulous points, which can be distinguished with difficulty; the larger ones are surrounded with a variable, ill-defined, and indistinct nebulosity. The comet of 1729 continued visible during six months: its orbit was computed by three different astronomers, whose results were far from coinciding. The same uncertainty exists with regard to the orbits of several other comets. When, therefore, all these circumstances are taken into consideration, it will not appear surprising that, although the elements of above 150 comets have been computed, there are only three which are certainly known to have been observed in their successive revolutions.

The first of the three periodic comets with which we are yet acquainted was made known to astronomers by Dr Halley. That active and indefatigable genius, having perceived that in 1682 the elements of its orbit were nearly the same as those of two comets which had respectively appeared in 1531 and 1607, concluded that the three orbits belonged to the same identical comet, of which the periodic time was about 76 years. After a vague estimate of the perturbations it must sustain from the attraction of the planets, Dr Halley predicted its return for 1757,—a bold prediction at that time, but justified by the event, for the comet again made its appearance as was expected, though it did not pass through its perihelion till the month of March 1759, the attraction of Jupiter and Saturn having caused, as was computed by Clairaut previously to its return, a retardation of 618 days. This comet had been observed in 1006; and the accounts which have been preserved represent it as having then appeared to be four times the size of Venus, and to have shone with a light equal to a fourth of that of the moon. History is silent respecting it from that time till the year 1456, when it passed very near to the earth: its tail then extended over 60° of the heavens, and had the form of a sabre. An ob-

ject so striking and so terrific could not fail, in a superstitious age, to excite universal dismay, and be regarded as portentous of the greatest calamities to the human race, if not of the destruction of the world. Accordingly Pope Calixtus ordered public prayers to be said over Christendom, in which he exorcised the comet, and the Turks, who had at that time made themselves masters of Constantinople, and overthrown the eastern empire. Dr Halley's comet will return to its perihelion in 1835; but whether on this occasion it will present any resemblance to its former appearances, or whether it will even be visible in Europe, cannot be certainly determined. The following table of its elements in 1835 is given by Pontécoulant (*Théorie Analytique du Système du Monde*, tome ii. p. 147):

Instant of the passage through the perihelion	
in October 1835.....	31 ^d .2
Semixis major.....	17.98355
Ratio of the eccentricity to the semixis major..	0.967453
Place of the perihelion on the orbit.....	304° 34' 19"
Longitude of the ascending node.....	55 6 59
Inclination.....	17 46 50.

The two other comets whose periodic returns have been verified by observation have received the names of Encke and Biela, the astronomers who first computed their orbits, or recognised them as having been observed in their previous revolutions. The first returns to its perihelion in 1208 days, and the second in 2440 days. Encke's comet, although its identity was not discovered till 1818, has been frequently observed, as in 1789, 1795, 1801, and 1805, and on these occasions it exhibited very different appearances, having been seen with and without a nucleus, with and without a tail,—circumstances which account for its having so long escaped being recognised as a regular attendant on the sun. In its returns to its perihelion in 1808, 1812, and 1815, it escaped detection; but it re-appeared in 1818, and it was from the observations of this year that Encke computed the elliptic elements of its orbit. On its next return, in 1822, it was invisible in Europe; but it was observed at Paramatta, in New South Wales, during the whole month of June, and the time of its perihelion passage was found to differ only by about three hours from that previously computed by Encke. On its returns in 1825 and 1828 its observed and computed places agreed equally well. The following, according to Pontécoulant, are its elements for 1829–30, computed from the observations at Paramatta:

Passage through the perihelion, 1829, January	10 ^a .573
Mean diurnal motion.....	1069.5570
Eccentricity.....	0.8446862
Place of perihelion.....	157° 18' 35"
Longitude of ascending node.....	334 24 15
Inclination.....	13 22 34.

Encke's comet presents in some respects a considerable analogy with the planet Ceres, the inclination and greater axis of its orbit being the same, while its sidereal revolution is only 46 days shorter than that of Vesta. The orbit is, however, greatly more elongated, for its perihelion falls within the orbit of Mercury, and its aphelion is situated between Jupiter and the new planets. The perturbations it sustains are chiefly occasioned by the attraction of Jupiter, that of the earth and Venus being extremely small, while the action of Mercury is insensible.

The third periodic comet with which our knowledge of the solar system has recently been enriched receives its name from Biela, by whom it was first perceived in Bohemia, on the 25th of February 1825. The parabolic elements computed from the first observations presented a striking resemblance with those of two comets

Theoretical Astronomy. which had been observed in 1772 and 1806, which induced MM. Clausen and Gambart, the first at Marseilles and the second at Altona, to compute the elements of the three comets on the hypothesis of elliptic orbits; and, after some attempts, each found an ellipse which represented all the observations so accurately as to leave no doubt of the identity of the comet. Its period is six years and about nine months, and it will return to its perihelion in November 1832, about the same time with Encke's. The following table of its elements has been computed from the observations of 1826, and the theory of the perturbations (Pontécoulant, tome ii. p. 158):

Passage through the perihelion 1832, November	27 ^d 4808
Eccentricity.....	0.7514481
Place of the perihelion.....	109° 56' 45"
Longitude of ascending node.....	248 12 24
Inclination.....	13 13 13
Semixis major.....	3.53683.

Such is the present state of astronomy with respect to periodic comets. There are two others besides, of which the orbits are supposed to be known, though their returns to their perihelia have not yet been verified. The first is that which appeared in 1680, and of which Newton computed the period to be 575 years. It may therefore be identical with those which are recorded in history to have appeared in 1106, 531, 34 B. C. and 619 B. C. The second is that which appeared in 1556, and is supposed to have made a former visit in 1264. This comet is expected to appear again in 1848.

The following table, taken from one given by Delambre in the third volume of his *Astronomie*, shows the comparatively small distances within which the greater part of the comets hitherto observed approach to the sun, and the apparently fortuitous inclinations of the planes of their orbits to that of the ecliptic. Supposing the sun's distance from the earth to be unity, then, of 120 comets, there are

5	whose perihelion distance is less than...	0.1
3	between 0.1 and 0.2	
6	0.2 and 0.3	
11	0.3 and 0.4	
10	0.4 and 0.5	
22	0.5 and 0.6	
12	0.6 and 0.7	
11	0.7 and 0.8	
8	0.8 and 0.9	
9	0.9 and 1	
21	1 and 2	
1	equal to 2.293	
1	4.069.	

Of the same number there are

4	whose inclination is between.....	1° and 5°
3	5 and 10	
4	10 and 15	
3	15 and 20	
2	20 and 25	
2	25 and 30	
7	30 and 35	
2	35 and 40	
4	40 and 45	
1	45 and 50	
3	50 and 55	
4	55 and 60	
7	60 and 65	
3	65 and 70	
3	70 and 75	
3	75 and 80	
4	80 and 85	
2	85 and 90.	

Theoretical Astronomy. The motions of the above 61 are direct; those of the remaining 59 are retrograde, and their orbits are distributed over the whole quadrant in the same random manner. This circumstance sufficiently indicates that the mechanical causes, whatever they were, which gave the same direction to the two motions of translation and rotation of all the planets and satellites, exercised no influence on the comets. Hence many astronomers have entertained the idea that these bodies have only a casual or transient connection with the planetary system.

SECT. II.—Of the Appearances and Physical Constitution of Comets.

Of all the celestial phenomena, those of the comets are the most striking, and the most calculated to impress the ignorant with the idea of supernatural agency. Appearing suddenly in the heavens, and under aspects the most uncommon and terrific, they have been almost universally regarded as visible demonstrations of the wrath, and harbingers of the vengeance, of offended deities. These superstitious terrors, arising from that vain propensity of the mind of man to regard the universe as created for himself alone, have only been dissipated by the progress of sound philosophy, and a more extended acquaintance with the riches of nature, and the endless variety of her productions.

The appearances exhibited by the comets are exceedingly diversified, and sometimes extremely remarkable. That which appeared in the year 130 B. C., at the birth of Mithridates, is said to have had a disk equal in magnitude to that of the sun. Ten years before this, one was seen, which, according to Justin, occupied a fourth part of the sky, that is, extended over 45°, and surpassed the sun in splendour. Another, equally remarkable, appeared in the year 117 of our era; and in 479 there was one of which the disk, according to Freret, was of such magnitude that it might have occasioned the extraordinary eclipse of the sun which took place about that time. In 400 one was observed, which is said, on the authority of Gainas, to have resembled a sword, and to have extended from the zenith to the horizon. That of 531 was of greater magnitude still, and its appearance more terrific. Those which appeared in 1066 and 1505 exhibited disks larger than that of the moon. It is, however, highly probable that all these accounts have been greatly exaggerated, through the ignorance and credulity of the historians by whom they are related; for, since comets have been observed by astronomers, no instances have occurred in which their magnitudes and appearances have been so extraordinary. The most remarkable among those of which we possess accurate accounts appeared in the years 1456, 1618, 1680, 1744, 1759, 1769, 1807, and 1811.

Fig. 106 is a representation of the celebrated comet of Plate C. 1680, taken from Lemonnier's *Histoire Céleste*. It exhibits the nucleus or disk with its surrounding atmosphere. Above is a sort of ring, wider at the summit, and narrower towards the sides. A *coma* or beard succeeds the ring; and lastly, an immense train of luminous matter, somewhat less vivid than the nucleus. This luminous train, or tail as it is called, is by far the most singular and striking feature presented by the comets. That of the comet of 1744 was one of the most remarkable. It was divided into six branches, all diverging, but curved in the same direction; and between the branches the stars were visible. It is represented in fig. 107. The tail of the comet of 1811 was composed of two diverging parts inclined to each other in an angle which varied from 90 to 15 or 20 degrees. These branches were curved in opposite directions, and descended from the nucleus like a veil: between the

Theoretical branches, and surrounding the nucleus, was a space comparatively obscure.

The nucleus, which is the densest and most luminous part, may be said to form the true body of the comet. It is, however, so far from having the dense and solid appearance of the planets, that some astronomers have imagined it to be diaphanous, and even supposed that they have observed stars through it. But supposing such an observation certain, it may be accounted for with much greater probability by the effects of refraction; and it is besides extremely difficult to distinguish the nucleus from the surrounding nebulosity. If the nucleus were an opaque globular body, it would exhibit phases like Venus or Mars, according to its different positions with relation to the sun and the earth; and such were observed, or at least were supposed to be observed, in the case of the comet of 1682, by Hevelius, Picard, and Lahire. But the nebulosity renders the phases exceedingly obscure and indistinct, and prevents the true body of the comet from being seen; in the same way as a globe of roughened glass prevents us from distinguishing the form of the flame of an inclosed lamp. The real nucleus has probably never been observed by any astronomer; and, from the appearances, we are led to infer that a comet, at least near its perihelion, is only an agglomerated mass of vapours. As it recedes from the perihelion, the vapours may be condensed by cold into a solid substance. This hypothesis is also favoured by the extreme smallness of the density of the comets, which is known certainly from the circumstance that they produce no appreciable effect on the motions of the planets. The comet of 1770 traversed the system of Jupiter's satellites without causing any sensible perturbation of those small bodies. This comet also passed very near the earth; and Laplace calculated, that if its mass had been equal in density to that of the earth, the effect of its attraction would have increased the length of the sidereal year by two hours and twenty-eight minutes. But since its influence was altogether insensible, it is certain that its mass was not equal to the five thousandth part of that of the earth, and probably much inferior even to this quantity.

If the nuclei of comets are solid, the matter of which they are composed must be extremely fixed in order to enable them to resist the intense heat they necessarily experience in their approaches to the sun. According to the computation of Newton, the great comet of 1680, at its perihelion, was only distant from the sun by the 163d part of the semidiameter of the earth's orbit, where it would be exposed to a heat above 2000 times greater than that of red-hot iron,—a temperature of which we can form no conception, and which would instantly dissipate any substance with which we are acquainted.

In order to explain the singular phenomena of the train of light which frequently attends the comets, the following theory was proposed by Newton. The comets move in very eccentric orbits, and consequently, towards their perihelia, approach very near to the sun. The excessive degree of heat they sustain near this point of their orbits must convert into vapour every substance capable of vaporization; and hence the prodigious extent of their atmosphere in comparison of the smallness of their nuclei. When this atmosphere has acquired all the volatility of which it is susceptible, the impulsion its vapours receive from the solar rays, however feeble that force may be conceived to be, is sufficient to put them in motion, and drive them off in a direction opposite to the sun. Thus it is remarked, that the tail becomes most conspicuous after the comet has passed the perihelion, and that its direction, as was first observed by Appian, is the straight

line joining the centres of the sun and comet. The slight curvature which is generally observed may be accounted for by combining the motion given to the vapours by the impulsion of the sun's rays with the motion of the comet in its orbit; for the detached vapours are driven by the impact of the luminous particles beyond the sphere of the comet's attraction, and consequently cease to follow the direction of the nucleus. Hence the curvature of the tail must be greatest towards its extremity; and this is observed to be actually the case. It may be remarked, however, that although this hypothesis serves to explain the phenomena when all the branches of the tail are bent in the same direction, it is inapplicable when the directions of the curvature are opposite, as was the case with regard to the comet of 1811. In fact, no ultimate reasons for several of the phenomena exhibited by comets have yet been given which can be considered as entirely satisfactory.

The discovery of the periodic returns of certain comets necessarily put an end to the apprehensions and terrors which their unusual appearances were well calculated to excite, and proved them to be permanent bodies belonging to the same system, and acted on by the same laws, as the planets. But this very discovery gave rise to apprehensions of another kind, more natural, though, when closely examined, hardly more reasonable. Since the comets are so numerous, and their orbits traverse the planetary system in all directions, and come within the orbit of the earth, is there not a probability that some of them may come into contact with our globe, and destroy it by the direct collision; or at least approach so near as to produce the most disastrous effects by their attraction? Halley found that the comet of 1680 had approached its perihelion about the time of the universal deluge, and thought it probable that that great catastrophe might have been immediately occasioned by the earth's being enveloped in the aqueous vapours of its tail,—an idea which was afterwards more fully developed by Whiston. Lalande and Maupertuis have minutely detailed the terrible effects which might be produced by the shock of a comet, or even by its approach to our earth. The vapours brought by the tail would mingle with the atmosphere, and render it less respirable. The attraction of the nucleus would destroy the equilibrium of the ocean, and cause extraordinary inundations, which might sweep off the greater part of the human species. The direct shock might change the position of the earth's axis, or even cause the earth to leave its present orbit. It might then become a satellite of the comet, and be carried away with it to the extreme limits of the sun's attractive influence: or, as the mass of the comet would probably be inferior to that of the earth, the earth would carry the comet along with it in its orbit, and thus acquire a second moon; and it has even been surmised that the moon we actually enjoy may owe its origin to an accidental occurrence of this kind. But all these reveries have disappeared before the calculus, by which it is demonstrated that the orbit of the moon can never at any time have been greatly different from what it now is. The collision of a comet with the earth is not an impossible event; though so infinitely little probable, that it can never excite any just cause of alarm. The conjunctions of the planets anciently caused terrors still more unreasonable; and the eclipses, which now scarcely attract the notice of the vulgar, long rivalled the comets in the terrors which they occasioned to the inhabitants of the earth.

Various opinions have been entertained respecting the nature, and formation, and uses of the comets. Newton supposed that, as some of them pass so near to the sun as

Theoretical Astronomy.	13. Serpentarius, <i>Ophiuchus</i> ,	Serpentarius.
	14. Serpens,	The Serpent.
	15. Sagitta,	The Arrow.
	16. { Aquila, <i>Vultur</i> , et	{ The Eagle and
	Antinous,	Antinous.
	17. Delphinus,	The Dolphin.
	18. Equulus, <i>Equi Sectio</i> ,	The Horse's Head.
	19. Pegasus, <i>Equus</i> ,	The Flying Horse.
	20. Andromeda,	Andromeda.
	21. Triangulum,	The Triangle.

In the Zodiac.

22. Aries,	The Ram.
23. Taurus,	The Bull.
24. Gemini,	The Twins.
25. Cancer,	The Crab.
26. Leo,	{ The Lion, to which he joined some stars of Berenice's Hair.
27. Virgo,	The Virgin.
28. Libra, <i>Chela</i> ,	The Scales.
29. Scorpio,	The Scorpion.
30. Sagittarius,	The Archer.
31. Capricornus,	The Goat.
32. Aquarius,	The Water-bearer.
33. Pisces,	The Fishes.

Southern Constellations.

34. Cetus,	The Whale.
35. Orion,	Orion.
36. Eridanus, <i>Fluvius</i> ,	Eridanus, the River.
37. Lepus,	The Hare.
38. Canis Major,	The Great Dog.
39. Canis Minor,	The Little Dog.
40. Argo Navis,	The Ship.
41. Hydra,	The Hydra.
42. Crater,	The Cup.
43. Corvus,	The Crow.
44. Centaurus,	The Centaur.
45. Lupus,	The Wolf.
46. Ara,	The Altar.
47. Corona Australis,	The Southern Crown.
48. Piscis Australis,	The Southern Fish.

The constellations added by Hevelius are the following:—

1. Antinous,	Antinous.
2. Mons Menelai,	Mount Menelaus.
3. Asterion et Chara,	The Greyhounds.
4. Camelopardalus,	The Giraffe.
5. Cerberus,	Cerberus.
6. Coma Berenices,	Berenice's Hair.
7. Lacerta,	The Lizard.
8. Lynx,	The Lynx.
9. Scutum Sobieski,	Sobieski's Shield.
10. Sextans,	The Sextant.
11. Triangulum,	The Triangle.
12. Leo Minor,	The Little Lion.

The constellations added by Halley in the southern hemisphere are,—

1. Columba Noachi,	Noah's Dove.
2. Robur Carolinum,	The Royal Oak.
3. Grus,	The Crane.
4. Phoenix,	The Phoenix.
5. Pavo,	The Peacock.
6. Apus, <i>Avis Indica</i> ,	The Bird of Paradise.
7. Apis, <i>Musca</i> ,	The Bee or Fly.
8. Chamæleon,	The Chameleon.

One of the most important objects of practical astronomy is the formation of catalogues of the fixed stars, in

which their positions are determined for a given epoch; for it is only by means of registered observations that the state of the heavens can be compared at different times, and any changes which take place be detected. The apparent place of a star is easily determined by observation; but in order to render such observations available for the purposes of comparison, the mean place of the observed star must be computed and reduced to a given epoch; and this reduction, which involves a knowledge of the precession, nutation, aberration, and in general of all the motions which affect the star's apparent place, is only accomplished by a laborious process of calculation.

The principal catalogues of the stars which we possess are the following:—

Ptolemy's catalogue, which contains 1022 stars. The positions are referred to the ecliptic, and the longitudes are for the year 137 of our era. It is supposed that the greater part of the observations on which it is founded were made and computed by Hipparchus 267 years before, and that Ptolemy merely reduced them to his epoch by adding to each of the longitudes $2^{\circ} 40'$, which, according to him, was the amount of the precession of the equinoxes in that interval. This catalogue forms part of the *Almagest*.

The catalogue of Ulugh Beigh, containing 1017 stars.

Tycho's catalogue, which contains only 777 stars, in 45 constellations.

Riccioli's catalogue, which contains 1468 stars. Part of it, however, was merely copied from more ancient catalogues.

Bayer's catalogue, containing 1762 stars, in 72 constellations. It was published in his *Uranometria* in 1603. The third edition of this work appeared at Ulm in 1661.

The catalogue of Hevelius, which contains 1888 stars, of which it gives the latitudes, longitudes, right ascensions, and declinations, for the year 1661. Published in his *Prodromus Astronomiæ* in 1690.

Flamsteed's catalogue, containing 2884 stars. Published in the *Historia Cælestis Britannica* in 1725. A less perfect edition was given by Halley in 1712.

Catalogues of Lacaille.—The first of these, published in his *Astronomiæ Fundamenta*, contains 397 stars; the second, which is given in his *Cælum Australe Stelliferum*, contains 1942 of the stars in the southern hemisphere; and the third, which was reduced from his observations by the celebrated Bailly, contains the places of 515 zodiacal stars.

Mayer's catalogue, containing 998 zodiacal stars. It appeared in his *Opera Inedita*, Göttingen, 1775, and was reprinted in the *Connoissance des Temps* for 1778.

Bradley's catalogue, containing 587 stars. This was published in the first volume of his observations, edited by Hornsby, in 1798. The positions of 389 stars, calculated from Bradley's observations, had been given by Mason in the *Nautical Almanack* in 1773. Bradley's observations extended to 3000 stars, but the greater part of them remained useless to astronomy till they were reduced and made the subject of discussion by Bessel in his *Fundamenta Astronomiæ*, Regiomonti, 1818.

Maskelyne's catalogue of 36 stars.

Cagnoli's catalogue, containing 501 stars. Published in the *Memoirs of the Italian Society*.

Bode's catalogue, which contains 17,240 stars, reduced from the observations of various astronomers.

Piazzi's catalogue, which contains 6748 stars, reduced to the year 1800. In 1814 Piazzi published a new catalogue, comprising 7646 stars.

Zach's catalogue, inserted in his *Tabulæ speciales Aberrationis et Nutationis*, Gothæ, 1806.

Theoretical Astronomy. Catalogue of the Astronomical Society of London, containing 2881 stars, published in the second volume of their

Memoirs. Almost all the stars comprised in this catalogue are to be found in the catalogues of Bradley or Piazzi, from which they have been reduced to the year 1830.

In addition to the above, the records of great masses of observations may be found in the *Philosophical Transactions*, the *Connaissance des Temps*, and the various astronomical and scientific Journals. Lalande has registered in the *Memoirs of the Academy of Paris*, and his *Histoire Céleste*, the positions of no fewer than 50,000; and Bessel, of the Königsberg Observatory, who continues to explore the heavens with unabated zeal, has already examined an equal number. Astronomers are now aware of the importance of extending their researches to the most minute sidereal objects.

SECT. II.—Of the Parallax, Distance, Magnitude, and Number of the Fixed Stars.

The fixed stars being the points of departure from which all the celestial motions are estimated, one of the first objects in astronomy is to determine the amount and law of all the minute variations of position, real or apparent, to which they are subject. One of the most obvious consequences of the hypothesis of the annual motion of the earth is the existence of an annual parallax of the stars; but on account of the enormous distances of these bodies, this effect of the earth's motion is so small that it cannot be easily measured; and it is even doubtful, after all the attempts that have been made to detect it, whether it is at all sensible to the best instruments. The longest line which nature has furnished us with the means of actually measuring, is the circumference of our own globe. From this geometry teaches us how to find its diameter; and the diameter we employ as a scale with which to compare the distances of the sun and moon, and the other bodies of the solar system. But experience shows us that this scale, large as it is in our conceptions, is only an insensible point in comparison of the distances of the fixed stars. Astronomy has furnished us with another base, about 24,000 times longer than the former, or above 190 millions of miles. This is the diameter of the earth's orbit, which is most conveniently used for expressing the distances of the planets and comets from the sun. Yet even this immense line is insensible when compared with the distances of the stars; for, on observing the same star from its two extremities, at the end of six months, no variation whatever is perceptible in the star's position, after the proper corrections have been made for the small effects produced by different and known causes. The limits of the errors of modern observations cannot well be supposed to exceed 1". It follows, therefore, that, seen from the distance of the fixed stars, the diameter of the ecliptic, which exceeds 190 millions of miles, subtends an angle of less than 1". Had the annual parallax exceeded this small quantity, it could scarcely have escaped the multiplied efforts that have been made to detect it, not only by Bradley, whose observations, undertaken for the express purpose of determining the parallax of the stars, conducted him to the grand discoveries of the aberration and nutation, but also by other observers furnished with the more delicate instruments of the present day; and particularly the observations made with the splendid circle of the Greenwich Observatory, the *chef d'œuvre* of Troughton. Astronomers are, however, not entirely agreed as to the fact that the parallax is altogether insensible; and Dr Brinkley of the Dublin Observatory has perceived indications of its existence with regard to several stars. Dr Brinkley could dis-

cover no parallax in his observations on the circumpolar stars, with regard to which the changes of declination resulting from the precession are most appreciable. He did not even observe it in the case of the stars of the constellation *♎ Cygni*, some of which, having a very sensible proper motion, may, with great probability, be considered as being at a less distance from the earth; but in *Wega* (*α Lyræ*) he found a parallax of 1".13, and one of 1".42 in the star *Athair*, in the Eagle. Bradley supposed the parallax of Sirius to amount to 1". These facts are, however, disputed by other eminent observers. In a series of 14 stars Struve found the parallax to be negative; that is, the small change of position which the observations seemed to indicate was in a direction contrary to what it would have been if it had arisen from the annual motion of the earth. Mr Pond, the Astronomer Royal, thinks the probable value of the parallax cannot exceed 0".018, a quantity so extremely minute as to be altogether lost in the uncertainties of instrumental errors, and the errors of refraction, which are at least 20 times greater.

Let us concede for a moment the disputed parallax of 1", and inquire what must be the corresponding distance of the star. The semidiameter of the terrestrial orbit being taken at 95 millions of miles, the distance of a star whose parallax is 1" will be expressed by $\frac{1}{\sin. 1''} \times 95000000 = 206264 \times 95000000 = 19,595,080,000,000$, or about 20 billions of English miles. To assist the imagination in forming some idea of this almost inconceivable distance, we may calculate that a ray of light which darts from the sun to the earth in the space of 8 min. 7 sec., would require 206264×8 min. 7 sec., or 3 years and 216 days, to reach us from the star. A spider's thread before the eye of a spectator placed at the same distance would suffice to conceal the orbit of the earth; and the breadth of a hair would blot out the whole planetary system. But a star having a parallax of 1" is at a moderate distance in comparison of innumerable others, in which no parallactic motion whatever can be distinguished. Supposing the distance of one of these to be only a thousand times greater, a ray of light darted from it would travel between 3000 and 4000 years before it reached the earth; and if the star were annihilated by any sudden convulsion, it would appear to shine in its proper place during that immense period, after it had been extinguished from the face of the heavens. Pursuing speculations of this kind, we may conceive, with Huygens, that it is not impossible that there may exist stars placed at such enormous distances, that their light has not yet reached the earth since their creation.

When viewed with the naked eye, the magnitudes of the stars appear to be very different,—a circumstance which may be attributed either to a real diversity of magnitude, or, which is more probable, to the great differences in their distances. The sensible magnitudes which they exhibit when viewed in this manner are owing only to the numerous reflections of the rays of light from the aerial particles surrounding the eye; as is proved by looking at them through a long tube, which prevents any rays from reaching the eye excepting those which come directly from the star. In the telescope their dimensions are entirely inappreciable: the greater the power with which they are viewed, the smaller are their apparent diameters, because they are then more completely divested of the effects of irradiation. A star having a diameter of 1", and an annual parallax of 1", would be more than a million of times larger than the sun. Nevertheless, Sir W. Herschel assures us, that, by means of the great powers which his telescopes carried, he had seen the disks of some stars perfectly round, and had even succeeded in measuring

Theoretical Astronomy. their apparent diameters. He found the diameter of *Wega* to be $\frac{1}{3}$ ", that of *Aldebaran* $1''\cdot5$, and that of *Capella* $2''\cdot5$. Supposing the measurement accurate, and the annual parallax of this last not to exceed $1''$, its volume would be equal to 20 million times that of the sun.

Number of the stars. With regard to the number of the stars, it is altogether impossible to form any satisfactory conjecture. Of those which are visible to the naked eye, the number does not, probably, at any time, exceed 1000, although, from the effect of their twinkling, and the confused manner in which they are seen, one is apt to suppose them to be much more numerous; but in the telescope they are prodigiously multiplied. Within the limits of a space extending 15° by 2° , Herschel counted no fewer than 50,000. In the single constellation of the Pleiades, instead of 6 or 7, which can be distinguished by the unassisted vision, Hooke, with a telescope of 12 feet, counted 78; and in telescopes of greater power the number appears to be vastly larger. Although, by reason of their very unequal distribution, no accurate estimate can be formed of the number contained in the whole sphere by the examination of any small portion of it, yet there is some reason to conclude that there cannot be less than 75 millions of stars altogether visible in a good telescope. Baron Zach estimates that there may be at least a thousand millions of stars in the entire heavens, without reckoning (what may probably exist) opaque bodies which cannot be perceived, and stars whose light has been extinguished. It is, however, evident that all estimates of this sort have no other limit than such as is imposed by the imagination. If an observer could be transported to the remotest star visible in his telescope, he would probably see extending before him in the same direction, a firmament equally rich and splendid as that which he beholds from our own insignificant planet.

SECT. III.—Of the Proper Motions of the Stars.

In Chap. II. four different causes of apparent motion with regard to the stars have been explained; namely, the precession of the equinoxes, the nutation of the earth's axis, the secular diminution of the obliquity of the ecliptic, and the aberration of light; all which are occasioned by the various motions proper to the earth, and for that reason are called apparent motions. But if, after due allowance has been made for the effects produced by them, it should happen that the observed place of any star, or number of stars, does not correspond with former observations, a new and peculiar motion would be indicated, which must be explained by a new hypothesis. Now there are obviously two ways of accounting for such a phenomenon, namely, a parallax motion and a proper motion, from either of which the observed variation of position may result. It has already been shown that the annual parallax, or that apparent alteration in the places of the fixed stars which might be expected from the motion of the earth in its orbit, is insensible; but we may suppose, and indeed observation has even rendered it probable, that the sun, accompanied by his whole train of planets and comets, is in motion in space; and if this is the case, the stars must appear to change their relative situations as soon as the sun has described a space bearing a sensible ratio to their distance. The resulting motion would thus partake of the nature of parallax, and is hence termed parallaxic. The other method of accounting for any observed alteration in the mutual position of the stars, is to ascribe to them a proper motion, instead of supposing them to be absolutely fixed. On this supposition the motion is real; yet it may happen that the observed changes of po-

sition result from the combined effects of a real and parallaxic motion. The effects of these motions are in their nature sufficiently distinct, although, on account of the extremely minute quantities to be determined, and the uncertainty that still exists as to the exact amount of some of the apparent motions with which they are blended, it may for centuries to come be found impossible to separate them. If all the stars forming a group, or situated in the same quarter of the heavens, appear to recede from or approach to each other, their motions may with reason be ascribed to the translation of the solar system in space, and consequently be parallaxic: but if, on the contrary, some appear stationary, while others appear to move in different directions, the phenomena will indicate a real change in the positions of the stars.

From the analogy of our own system we are naturally induced to extend the principle of gravity to the sphere of the stars, and to suppose, as a necessary consequence, that none of the celestial bodies are in a state of absolute repose. Their mutual attraction must communicate to them a motion which would end in uniting them all in the same mass unless it were counteracted by a centrifugal force: hence the stars are supposed to move about distant centres in orbits analogous to those of the planets. But if the stars are not absolutely at rest in space, their motions must be extremely slow, inasmuch as the actual state of the heavens corresponds entirely with the descriptions that have been given of it by Hipparchus and Ptolemy. Ptolemy has transmitted to us a great number of observations on the relative situations of the fixed stars, made by Hipparchus, whose method was to observe those which are situated in an arc of the same circle, or which can be intersected by the same straight line; and he assures us that he himself, after an interval of 260 years, could perceive no alteration. In order to furnish posterity with the means of pursuing similar inquiries, Ptolemy added the positions of many other stars determined by his own observations; and we owe to his labours the certain knowledge that the relative positions of the stars, notwithstanding the numerous displacements of the ecliptic and equator, are at present nearly the same as they were 2000 years ago. The ancient observations were, however, of too rude a nature to admit of any satisfactory conclusion being deduced from them respecting the minute quantities in question. The accurate instruments of the present day have enabled observers to remark some changes of position too decided to admit of doubt; hence astronomers have inferred a proper motion in several stars, as well as a translation of the sun and the planets in space. From the comparison of a great number of observations, Sir W. Herschel was of opinion that many of the proper motions might be explained by supposing the solar system to have a motion directed towards the star λ in the constellation Hercules. This conjecture has not, however, been confirmed, or rather it has been entirely overthrown, by subsequent observations. Bessel, having subjected to a rigorous comparison a much greater number of the proper motions indicated by comparing the catalogues of Bradley, Mayer, Piazzini, &c. arrived at the conclusion that many points might be assigned in the sphere, some of them even diametrically opposite to each other, situated in the direction of those motions; but that, in whatever direction the sun is supposed to move, so many proper motions will remain unaccounted for, that there is no reason for preferring one point to another. The proper motions of the stars which have hitherto been remarked are evidently subject to no one assignable law, and are directed to many different points in space. It is therefore infinitely probable that they are due, in part at least, to a real dis-

Theoretical placement of the stars, and not to a general translation of Astronomy. the solar system.

Some recent observers have supposed they have detected proper motions in a great number of stars, the rates of which they have inserted in their catalogues along with those of the precession; but there is great discordancy in the determinations of different astronomers. Baron Zach, comparing Maskelyne's observations of the right ascensions of the Greenwich stars, reduced to 1802, with those of Bradley, reduced to 1760, found results which differ from those of Maskelyne himself, not only in amount, but in several instances even in the direction of the supposed proper motions. For example, the proper motions (in right ascension) of γ Pegasi, α Ceti, Rigel, Sirius, Spica, γ and β Aquilæ, α Cygni, α Aquarii, and α Pegasi, are all positive according to Zach, while Maskelyne considers them as being all negative. Such is the uncertainty respecting the proper motions even of the Greenwich stars, which, by reason of the frequent observations they have undergone, and the rigorous scrutinies to which they have been subjected, are probably those whose places are the most accurately determined of any in the whole heavens. But the motions are so slow that they must remain,

for a considerable number of years at least, blended with the errors of observation. The double star 61 Cygni is indeed supposed by Bessel to have an annual proper motion of $+5''.06$ in right ascension, and $3''.34$ in declination; but in general the rates are confined within much narrower limits, and appear to amount only to a fraction of a second. The number of stars in which this proper motion has been supposed to be observed is, as we have already noticed, very considerable. M. Bessel, by a comparison of 2959 stars out of Bradley's catalogue, with the same stars in the catalogue of Piazzi, found that 425 of them had an annual proper motion, amounting to more than $0''.2$, in the arc of a great circle. The following table, published by Mr Baily in the second volume of the Memoirs of the Astronomical Society, contains a list of all those stars observed by Bradley and Mayer, whose annual proper motions, according to Piazzi, as given in his catalogue, amount to $0''.5$ either in right ascension or declination. The positive sign, in the column of declinations, denotes a motion towards the north, the negative a motion towards the south. The numbers prefixed are those of Flamsteed, unless when inclosed within a parenthesis, in which case they are those of Piazzi.

Star.	Proper motion in		Star.	Proper motion in	
	Δ .	D.		Δ .	D.
11 β Cassiopeiæ.....	$+0''.82$		5 θ Centauri.....	$-0''.63$	
24 η Ditto.....	$+1''.78$	$-0''.72$	16 α Bootis.....	$-1''.17$	$-1''.96$
37 μ Andromedæ.....	$+1''.20$		19 λ Ditto.....	$-0''.55$	
1 Polaris.....	$+1''.47$		23 θ Ditto.....	$-0''.80$	$-0''.54$
37 δ Cassiopeiæ.....	$+0''.64$		44 Ditto.....	$-0''.91$	
107 Piscium.....		$-0''.57$	41 γ Serpentis.....		$-1''.31$
52 τ Ceti.....	$-1''.86$	$+0''.84$	49 Libræ.....	$-0''.75$	
13 θ Persei.....	$+0''.67$		18 Scorpii.....		$-0''.53$
12 Eridani.....	$+0''.64$	$+0''.82$	40 ζ Herculis.....	$-0''.70$	
23 δ Ditto.....		$-0''.60$	26 ϵ Scorpii.....	$-0''.65$	
27 μ' Ditto.....		$-0''.59$	36 α Ophiuchi.....	$-0''.59$	$-1''.25$
40 d Ditto.....	$-2''.21$	$-3''.60$	30 Scorpii.....	$-0''.58$	$-1''.24$
1 Orionis.....	$+0''.54$		22 ϵ Ursæ Min.....	$-0''.82$	
104 m Tauri.....	$+0''.69$		27 f Draconis.....	$-0''.51$	
15 δ Leporis.....		$-0''.62$	86 μ Herculis.....		$-0''.84$
9 α Can. Maj.....	$-0''.51$	$-1''.14$	70 p Ophiuchi.....		$-1''.17$
10 α Can. Min.....	$-0''.71$	$-0''.98$	58 η Serpentis.....	$-0''.67$	$-0''.68$
78 β Geminorum.....	$-0''.72$		44 χ Draconis.....	$+1''.72$	
15 ψ^3 Cancræ.....	$-0''.60$		(50) Sagittarii.....		$-0''.54$
9 ι Ursæ Maj.....	$-1''.05$		31 b Aquilæ.....	$+0''.92$	$+0''.72$
81 π Cancræ.....	$-0''.55$		3 Cygni.....		$-0''.72$
25 θ Ursæ Maj.....	$-1''.80$	$-0''.60$	61 σ Draconis.....	$+1''.28$	$-2''.12$
29 ν Ditto.....	$-0''.60$		53 α Aquilæ.....	$+0''.51$	
7 α Crateris.....	$-0''.59$		60 β Ditto.....		$-0''.54$
63 χ Leonis.....	$-0''.53$		15 z Sagittæ.....	$-0''.50$	
53 ξ Ursæ Maj.....	$-0''.52$	$-0''.64$	(29) r Sagittarii.....	$+1''.24$	$+0''.76$
94 β Leonis.....	$-0''.53$		1 z Cephei.....	$-0''.80$	
5 β Virginis.....	$+0''.76$		3 η Ditto.....		$+0''.81$
16 c Ditto.....	$-0''.55$		61 Cygni.....	$+5''.38$	$+3''.30$
5 x Draconis.....	$-0''.50$		3 Piscis Aust.....	$-1''.09$	
3 Canum Ven.....	$-1''.02$		65 τ Cygni.....		$+0''.50$
29 γ Virginis.....	$-0''.72$		(36) Lacertæ.....	$+0''.75$	$-0''.80$
43 δ Ditto.....	$-0''.65$		6 γ Piscium.....	$+0''.78$	
43 Com. Ber.....	$-1''.19$	$+0''.94$	17 ι Ditto.....		$-0''.55$
61 Virginis.....	$-1''.30$	$-1''.08$	(249) Ditto.....	$+0''.70$	
70 Ditto.....		$-0''.53$	85 Pegasi.....	$+0''.90$	$-1''.15$
85 η Ursæ Maj.....	$-0''.50$				

The proper motions of the stars are not susceptible of direct observation or measurement: they are only indicated by the minute differences which remain after applying to

the observed position of any given star the corrections due to all the apparent motions with which we are acquainted. Thus, let M and M' be the mean places of any given star

Theoretical Astronomy. at two different epochs, the interval between which is t years; P the annual precession of the equinoxes, and x the annual motion of the star in right ascension. It is obvious that x will be given by the formula

$$x = \frac{M - M'}{t} - P;$$

so that the value of x , or the amount of the proper motion, is dependent not only on the accuracy of the observations, and on the computations from which M and M' , the mean places of the star, have been deduced, but also on the quantity P , which is calculated by a method of approximation not entirely exact. For all these reasons it is easy to see that the determination of the proper motions must be attended with considerable uncertainty, and that hundreds, probably thousands, of years will be required to develop their rates and directions, and assign the distant centres round which they are performed.

SECT. IV.—Of Variable and Double Stars, Nebulæ, and the Milky Way.

The periodical variations of brilliancy to which some of the fixed stars are subject, may be reckoned among the most remarkable of the phenomena exhibited by those bodies. Several stars, formerly distinguished by their splendour, have entirely disappeared; others are now conspicuous which do not seem to have been visible to the ancient observers; and there are some which alternately appear and disappear, or of which the light at least undergoes great periodic variations. Some seem to become gradually more obscure, as δ in the *Great Bear*; others, like β in the *Whale*, to be increasing in brilliancy. Some stars have all at once blazed forth with great splendour, and, after a gradual diminution of their light, have again become extinct. The most remarkable instance of this sort is that of the star which appeared in 1572, in the time of Tycho. It suddenly shone forth in the constellation Cassiopeia with a splendour exceeding that of stars of the first magnitude, even of Jupiter and Venus at their least distances from the earth, and could be seen with the naked eye on the meridian in full day. Its brilliancy gradually diminished from the time of its first appearance, and at the end of sixteen months it entirely disappeared, and has never been seen since. During the whole time of its apparition its place in the heavens remained unaltered, and it had no annual parallax; its distance was consequently of the same order as that of the fixed stars. Its colour, however, underwent considerable variations. Tycho describes it as having been at first of a bright white; afterwards of a reddish yellow, like Mars or Aldebaran; and, lastly, of a leaden white, like Saturn. Another instance of the same kind was observed in 1604, when a star of the first magnitude suddenly appeared in the right foot of Ophiuchus; it presented phenomena analogous to the former, and disappeared in like manner after some months. Kepler wrote a book on this singular apparition. These instances sufficiently prove that the stars are subject to great physical revolutions.

A great number of stars have been observed whose light seems to undergo a regular periodic increase and diminution, and these are properly called *variable stars*. One in the *Whale* has a period of 334 days, and is remarkable for the magnitude of its variations. From being a star of the second magnitude, it becomes so dim as to be seen with difficulty through powerful telescopes. Some are remarkable for the shortness of the period of their variation. *Algol* has a period of between two and three days, δ *Cephei* one of $5\frac{1}{3}$ days, β *Lyræ* one of $6\frac{2}{3}$ days, μ *Antinoi* one of 7 days. The regular succession of these

Theoretical Astronomy. variations precludes the supposition of their being occasioned by a real or permanent destruction of the stars; neither can they be supposed to arise from a change of distance; for as the stars invariably retain their apparent places, it would be necessary to suppose that they approach to and recede from the earth in straight lines,—an hypothesis which is at least extremely improbable. The most probable supposition is, that the stars revolve, like the sun and planets, about an axis; and that the surfaces of the variable stars are unequally covered with dark spots, or unequally fitted to emit light; whence their dark sides will be turned towards us after certain intervals by the effect of rotation. In this way Newton accounted for the phenomena. Other astronomers have devised different explanations. Maupertuis supposed that the figure of the stars is not globular, but flat, and that the variations of brilliancy depend on the angle which their flat sides make with the visual ray,—an angle which will be constantly varying if the stars are endowed with a rotatory motion. Others, again, have imagined that the partial obscurations of the stars may be occasioned by their being eclipsed by opaque bodies or planets revolving round them.

On examining the stars with telescopes of considerable power, many of them are found to be composed of two or more stars placed contiguous to each other, or of which the distance subtends a very minute angle. This appearance is probably in many cases owing solely to the optical effect of their position relative to the spectator; for it is evident that two stars will appear contiguous if they are placed nearly in the same line of vision, although their real distance may be immeasurably great. There are, however, many instances in which the angle of position of the two stars varies in such a manner as to indicate a motion of revolution about a common centre; and in this case the two stars form a binary system, performing to each other the office of sun and planet, and connected together by gravity or some equivalent principle. The recent observations of Messrs Herschel and South have placed this singular fact beyond doubt. Motions have been detected so rapid as to become measurable within very short periods of time; and at certain epochs the satellite or feebler star has been observed to disappear, either on passing behind or before its primary, or by approaching so near to it that its light has been absorbed by that of the other. The most remarkable instance of a regular revolution of this sort is that of the double star ξ *Ursæ Majoris*, in which the angular velocity is $6^{\circ}.4$ annually, so that the two stars complete a revolution about one another in the space of 60 years; and above three fourths of a circuit have been already described since its discovery in 1781. The double star p *Ophiuchi* presents a similar phenomenon, and the satellite has a motion in its orbit still more rapid. α *Castoris*, γ *Virginis*, ζ *Cancri*, ξ *Bootis*, δ *Serpentis*, and that remarkable double star 61 *Cygni*, together with several others, exhibit similar variations in their respective angles of position.

The examination of double stars was first undertaken by Sir W. Herschel, with a view to the question of parallax; for it is evident, and indeed had been remarked by Galileo, that the apparent distance of two stars which are very near each other will vary with the position of the earth in its orbit, unless they are both so remote that, in comparison of their distance from the earth, the diameter of the terrestrial orbit is insensible. His attention was, however, soon arrested by the new and unexpected phenomena which these bodies presented. Sir W. Herschel observed in all 2400 of them. Messrs South and Herschel have given a catalogue of 380 in the Transactions of the

Theoretical Astronomy. Royal Society for 1824, and South added 458 to the list in the volume for 1826. Mr Herschel has published three series of observations in the Memoirs of the Astronomical Society, containing altogether 1000 double stars; and the catalogue of M. Struve of Dorpat contains 3063 of the most remarkable. The object of these catalogues is not merely to fix the place of the star within such limits as will enable it to be easily discovered at any future time, but also to record a description of the appearance, position, and mutual distances, of the individual stars composing the system, in order that subsequent observers may have the means of detecting their connected motions, or any changes with which they may be affected. M. Struve has also taken notice of 52 triple stars, among which No. 11 of the *Unicorn*, ζ of *Cancer*, and ξ of the *Balance*, appear to be ternary systems in motion. Quadruple and quintuple stars have likewise been observed, which also appear to revolve about a common centre of gravity. Every region of the heavens furnishes examples of these curious phenomena, especially those which abound in stars; though M. Struve remarks that some parts of the milky way contain very few, while others present them in great abundance.

Some of the double stars present curious instances of contrasted colours, and generally assume the complementary tints,—a circumstance which, Mr Herschel thinks, may be owing in some degree, at least in cases where red and green, yellow and blue stars are combined in a double star, to the influence of optical deception. “When I first observed,” says that ingenious philosopher, “the double star No. 881, A. E. 19 hours 8 minutes 56 seconds, P. D. $95^{\circ} 45' 33''$, I remarked it as a case of contrasted colour, the large star being ruddy, and the small one blue. But on closer attention I perceived the small star itself to be double; yet each of the two very minute stars of which it consists appeared equally blue while the eye continued under the influence of the large one; but when this was withdrawn from the field, they appeared of no particular colour, but just like other small stars in the neighbourhood. It may be remarked further, too, that yellow stars are, generally speaking, accompanied by blue small ones, blue being the complementary tint of yellow; but when the large star has an excess of red rays, the blue verges to green, as it ought on the hypothesis of contrast. A most remarkable instance is that of No. 895 (Struve’s catalogue), A. E. 6 hours 12 minutes, P. D. $84^{\circ} 12'$, in which the large star is of a full ruby red, and the smaller one of a fine green, but which colour it also loses when the large star is concealed behind the cross of the wires.” (*Memoirs of the Astronomical Society*, vol. iii. p. 186.)

Nebulæ. The *Nebulæ*, so called from their dim cloudy appearance, form another class of objects which furnish matter for curious speculation and conjecture respecting the formation and structure of the sidereal heavens. When examined with a telescope of moderate powers, the greater part of the nebulae are distinctly perceived to be composed of clusters of little stars, imperceptible to the naked eye, because, on account of their apparent proximity, the rays of light proceeding from each are blended together, through the effects of irradiation, in such a manner as to produce only a confused luminous appearance. In others, however, no individual stars can be perceived, even through the best telescopes; and the nebula exhibits only the appearance of a self-luminous or phosphorescent patch of matter in a highly dilated or gaseous state; though it is possible that even in this case the appearance may be owing to a congeries of stars so minute, or so distant, as not to afford singly sufficient light to make an impression on the eye. In some instances the nebula

Theoretical Astronomy. presents the appearance of a faint luminous atmosphere, of a circular form, and of large extent, surrounding a star of considerable brilliancy. One of the most remarkable nebulae is that which is situated in the sword-handle of Orion. It was discovered by Huygens in 1656, and described and figured by him in his *Systema Saturnium*. Since that time it has been examined and described by various observers, particularly Fouchy, Mairan, Le Gentil, and Messier, who have given engravings of it; and if any trust can be placed in their descriptions of so indistinct and difficult an object, it must have undergone great changes in its form and physical appearances. Unfortunately, however, no satisfactory inference can be drawn from the comparison of the different descriptions; for it is found that the same nebula, viewed on the same night with different telescopes, presents appearances so different as to be scarcely recognizable as the same object. The effects of atmospherical variations also cause great differences in its appearance, even when it is viewed through the same telescope at different times; so that it is scarcely possible that any two observers will be found to agree in their delineations of its outline. Mr Herschel, in the second volume of the Memoirs of the Astronomical Society, has given a detailed description of this nebula as it appeared in his twenty feet reflector in 1824, together with a drawing which, on account of the superiority of his telescope, is probably a much more correct representation of the object than any which previously existed. Fig. 108 is copied from that drawing. Of that portion of the nebula which he calls the Huygenian region Mr Herschel gives the following account: “I know not how to describe it better than by comparing it to a curdling liquid, or a surface strewn over with flocks of wool, or to the breaking up of a *mackerel sky* when the clouds of which it consists begin to assume a cirrous appearance. It is not very unlike the mottling of the sun’s disk, only (if I may so express myself) the grain is much coarser, and the intervals darker; and the flocculi, instead of being generally round, are drawn out into little wisps. They present, however, no appearance of being composed of small stars, and their aspect is altogether different from *resolvable nebulae*. In the latter we fancy that we see stars, or that, could we strain our sight a little more, we should see them; but the former suggests no idea of stars, but rather of something quite distinct from them.”

Plate XCI.

Another very remarkable nebula is that in the girdle of Andromeda, which, on account of its being visible to the naked eye, has been known since the earliest ages of astronomy. It was re-discovered in 1612 by Simon Marius, who describes it as having the appearance of a candle seen through horn, that is, a diluted light, increasing in density towards a centre. Le Gentil mentions that its figure had appeared to him for many years round, but that in 1757 it had become oval. He also remarks that its light was perfectly uniform in all parts,—a fact which is quite at variance with its present appearance, and which, if true, argues that the nebulous matter is in a rapid state of condensation. “At present,” says Mr Herschel, in the volume above referred to, “it has not, indeed, a star or any well-defined disk in its centre; but the brightness, which increases by regular gradations from the circumference, suddenly acquires a great accession, so as to offer the appearance of a nipple, as it were, in the middle, of very small diameter ($10''$ or $12''$), but totally devoid of any distinct outline, so that it is impossible to say precisely where the nucleus ends and the nebula begins. Its nebulosity is of the most perfect milky, absolutely irresolvable kind, without the slightest tendency to that separation

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into flocculi above described in the nebula of Orion; nor is there any sort of appearance of the smallest star in the centre of the nipple. This nebula is oval, very bright, and of great magnitude, and altogether a most magnificent object."

Sir W. Herschel, who devoted himself to the examination of every uncommon appearance in the sidereal heavens, has given catalogues of 2000 nebulae and clusters of stars discovered by him, and has shown that the nebulous matter is distributed through the immensity of space in quantities inconceivably great, and in separate parcels of all shapes and sizes, and of all degrees of brightness between a mere milky appearance and the condensed light of a fixed star. Finding that the gradations between the two extremes were tolerably regular, he thought it probable that the nebulae form the materials out of which nature elaborates suns and systems, and conceived that, in virtue of a central gravitation, each parcel of nebulous matter becomes more and more condensed, and assumes a rounder form; that from the eccentricity of its shape, and the effects of the mutual gravitation of its particles, it acquires gradually a rotatory motion; that the condensation goes on increasing till the mass acquires consistency and solidity, and all the other characters of a comet or planet; that by a still further process of condensation the body becomes a real star, self-shining; and that thus the waste of the celestial bodies, by the perpetual diffusion of their light, is continually compensated and restored by new formations of such bodies, to replenish for ever the universe with planets and stars. (See the *Philosophical Transactions* for 1811.) These hypotheses or conjectures give no doubt a mechanical reason for the formation of stars, but the answer to them is exceedingly obvious. Has any instance as yet been observed of a nebula being succeeded by a star, or cluster of stars, or even of becoming so much more condensed as absolutely to change its form? Till a change of this sort has been observed, the inferences are drawn from analogies too slender to entitle them to be regarded as any thing more than mere fancies and speculations. Even if every link in the chain were per-

fect, and the gradation distinctly traced from the most diffuse nebula to the most compact star, the facts would still be insufficient to warrant the conclusion that the celestial matter had actually undergone a transition from the nebulous to the stellar state, or that any star or nebula in the heavens ever existed in a state different from its present. Though there is little reason to hope that we shall ever obtain a full knowledge of the mysterious processes which the great Architect of the universe has employed in the formation of the celestial bodies, yet a long series of observations with such instruments as are now constructed may lead to the detection of changes sufficiently indicative of the nature of the forces by which they are produced. These cosmological speculations, however, it may be well to remark, are not of the slightest value to astronomy.

That great luminous tract which encompasses the sky like a girdle, and is called the *Galaxy* or *Milky-Way*, is supposed by Sir W. Herschel to be a nebula of which the sun forms one of the component stars; and hence it appears immensely greater than other nebulae only in consequence of our situation with respect to it, and of its greater proximity to our system. On examining any part of it with a good telescope, we perceive a prodigious multitude of small stars, whose blended light occasions the whitish appearance which forms so remarkable an object in the heavens. Yet notwithstanding the apparent contiguity of the stars which crowd the galaxy, it is certain that their mutual distances cannot be less than a hundred thousand times the radius of the terrestrial orbit. From this we may attempt to form some notion of the inconceivable distances of the other nebulae, some of which, probably not inferior in magnitude to the milky-way, appear only as small luminous patches in the telescope.

See Tycho *de Nova Stella anni 1572*; Hevelius, *Historiola miræ Stellæ in Collo Ceti*, anno 1660; Maupertuis, *Figure des Astres*, Œuvres, tome i. Lyon, 1756; Michel, *Phil. Trans.* 1784; Pigott, *Phil. Trans.* 1785, 1797; Lemonnier, *Mém. Acad. Par.* 1789; Lalande, *Astronomie* (885); Herschel, *Phil. Trans.* passim. (s.)

PART III.¹

PHYSICAL ASTRONOMY.

THE whole science of astronomy may be reduced to two general problems. The first is to express the position of all the heavenly bodies in terms of the time reckoned from a given instant, either in the past or the future duration of the world. The same may be otherwise stated by saying, that the thing required is, to express the position of any one of the heavenly bodies in a function of the time, the time being considered as the only variable quantity, though combined with other known quantities, which enter into the function as the co-efficients of the different terms. This is the most general view of that which is usually called descriptive, or sometimes geometrical astronomy. The solution of this problem enables us to determine for any time the places of the heavenly bodies, relatively to one another, and relatively to any point on the earth's surface. It contains under it an endless variety of subordinate problems, embracing a long series of successive generalizations, from the first observations to the determination of the orbits of the heavenly bodies, and the final reduction of all that concerns their motions into

the form of astronomical tables. The second problem is, to compare the laws of motion in the heavens, as discovered from the preceding investigations, with the laws of motion as already known on the surface of the earth, in order to find out whether or not they are the same; and, if not, in what their difference consists. The solution of this problem constitutes what is called Physical Astronomy: it is the same with inquiring into the causes of the celestial motions; for by *causes* we mean the general facts concerning the motion of bodies which are observed to take place on the surface of the earth.

Though the first of these two problems goes necessarily before the second, for the solution of which it affords the *data*, yet, after this solution is obtained, it affords great assistance to many of the researches involved in the first, and exemplifies, in a most remarkable manner, the use of theory in the investigation of facts, and the re-action, as it were, of the second problem on the first.

Taking for granted the solution of the first problem, as given under the other Parts of this article, we are now to

¹ This portion of the present treatise is reprinted from the article on Physical Astronomy contributed by the late Professor Playfair to the *Supplement* to the fourth, fifth, and sixth editions of this work.

Physical Astronomy. consider the second, and to explain the manner in which it has been resolved by Newton and the philosophers who have come after him.

The history of the first of these two problems is long and interesting, beginning from the remotest period to which the records or the traditions of mankind have ventured to ascend, and coming down to the present time; and, in the ages to come, it is never likely to know any limit but the movable instant which separates the past from the future,—as long, at least, as science and civilization are inhabitants of the earth.

The history of the second comes within small compass; because, between the first rude effort and the last refined investigation there is hardly any intermediate step but one.

The concentric orbs of the ancient philosophers were an attempt at an explanation of the physical causes of the celestial motions, or at an assimilation of those motions to such as we are accustomed to see on the surface of the earth. The great phenomenon to be explained was the diurnal motion of the heavens, by which so many bodies, very distant from one another, all describe circles round the earth, keeping time so precisely with one another, that the revolutions, whether great or small, are accomplished in the same interval. This could not be, unless a connection subsisted between those bodies; and the most simple idea of that connection was, that the bodies were fixed in the surface of a sphere which revolved on an axis, and carried them along with it.

If the whole of astronomy had been confined to the single fact of the diurnal revolution of the fixed stars, the hypothesis just mentioned would have been quite satisfactory. But as some of the heavenly bodies, such as the sun and planets, did not revolve precisely in the same time with the rest, it was necessary to assign to them particular spheres of their own. Those spheres, therefore, must be transparent: light must find an easy passage through them, and hence they must be crystalline. By degrees, as more accurate knowledge was obtained of the motion of the planets, it was found necessary so to increase the number of the spheres, that the complication of the structure was burdensome to the imagination; the hypothesis did not answer the very first object of a theory, that of connecting the facts together; and it was so unlike any process of nature with which we are acquainted, that it was highly improbable. The hypothesis of the homocentric orbs therefore fell into discredit, and, after the discovery of the earth's motion, was entirely abandoned.

The next attempt to explain the whole system of the celestial motions was that of Descartes, by means of vortices of subtle matter, and the pressure which, by the centrifugal force of those vortices, was produced on the grosser bodies of the stars. But as a taste for accurate knowledge increased, and as men reflected more on the true objects of philosophic theory, the system of vortices appeared more and more defective, and at length ceased to have any followers.

Newton succeeded, who, rejecting all the cumbersome machinery, both solid and fluid, of his predecessors, adopted a plan far more philosophical in the design, and far more difficult in the execution, than any thing yet known in the physical or mathematical sciences. Assuming as true the three general facts concerning the planetary system known by the name of the laws of Kepler, he proceeded to inquire by what sort of action on one another the planets could be made to describe orbits having the properties indicated by these three general facts. The general facts to which we now refer, are,

I. *That every planet moves so, that the line drawn from it to the sun describes about the sun areas proportional to the times.*

Physical Astronomy. II. *That the planets describe ellipses, each of which has one of its foci in the same point, viz. the centre of the sun.*

III. *That the squares of the times of the revolutions of the planets are as the cubes of their mean distances from the sun.*

SECT. I.—Of the Forces which retain the Planets in their Orbits.

1. *If a body gravitating to a fixed centre have a motion communicated to it in a direction not passing through that centre, it will move in a curve, and the straight line drawn from the body to the centre will describe areas proportional to the times.*

Let S (fig. 109) be the centre to which the body A gravitates, at the same time that a motion is communicated to it in the direction AB. And first, let the gravitating or centripetal force be supposed to act, not continually, but at intervals, producing instantaneously, at the beginning of each interval, the same velocity that it would have produced by acting continually during the whole of that time: let AC be the space which the body would describe by the action of this force alone; also let AB be the space which it would describe in the same time by the projectile force acting on it alone. It will therefore describe the line AD, the diagonal of the parallelogram contained by AB and AC, and at the end of the first interval will be in D. If, then, no new impulse of gravity were to act on it, it would in the second interval of time go on in the direction AD, and describe DF equal to AD. But if, at the beginning of the second interval, an impulse of the centripetal force be instantaneously impressed, sufficient to carry the body in that time from D to E in the line DS, it will describe the line DG, the diagonal of the parallelogram contained by DE and DF. The same is true of the third interval, in which the body will go from G to L, and of every subsequent interval. Join SB, SF, SK, &c. The areas of the triangles ABS, ADS are equal, the triangles being on the same base AS, and between the same parallels AS and BD. For the same reason, the triangles DGS, DFS are equal, and DFS is equal to ADS, because they have equal bases and the same altitude. For the same reason, the triangle SGL is equal to SDG, or to ADS; and the same is true of all the other triangles that are described in the equal intervals of time by the line drawn from the body to the centre S. This holds, however short the intervals may be, and however great their number; and therefore it is true when the intervals are infinitely small, and their number infinitely great, that is, when the action of the centripetal force is continued.

But when the intervals of time become infinitely small, the rectilinear figure ADGL passes into a curve. For when these intervals diminish, the lines AB, DF, &c. the lengths of the parallelograms, diminish in the same proportion; but the lines AC, DE, &c. the breadths, diminish in a greater proportion, viz. in that of the squares of these intervals. Hence, the angles which AD, DG, GL, the diagonals, make with the sides AB, DF, GK, continually diminish; and therefore the angles ADG, DGL, or the angle which each diagonal makes with that which is contiguous, increases without limit, so that, as the diagonals diminish in length, the angles they make with one another become greater than any finite rectilinear angles, and therefore the figure becomes a curve line.

That the lines AC, &c. or the supposed effect of the centrifugal force, diminish as the squares of the times, is evident from the laws of the descent of heavy bodies, as explained under the head of Dynamics.

2. Hence, conversely, if a body move in a curve, so that the line drawn from it to a fixed point describe areas proportional to the times, the body gravitates to that point, or tends continually to descend to it.

Physical Astronomy. its velocity would be equal to 0, or the body must begin to fall from N, in order that its velocity may be everywhere equal to that which the planet has in its orbit, when at the same distance from the sun.

The law, therefore, according to which the planets gravitate is such, *that any body under the influence of the same force, and falling direct to the sun, will have its velocity at any point equal to a certain velocity, multiplied into the square root of the distance it has fallen through, divided by the square root of the distance between it and the sun's centre.*

This is a fact with respect to the law of gravity in the solar system, of which, though there be no direct example, yet is it no less certain than the ellipticity of the planetary orbits, of which it is a necessary consequence.

9. From the law thus found to regulate the velocity of bodies falling in straight lines to the sun, the law of the force by which that velocity is produced may be derived by help of reasoning which is quite elementary.

Let C (fig. 113) be the centre to which the falling body gravitates, A the point from which it begins to fall, and let its velocity at any point B, be to its velocity in the point G, which bisects AC, as $\sqrt{\frac{AB}{BC}}$ to 1; it is required to find the law of the force with which the body gravitates to C.

Let DEF be a curve, such, that if AD be an ordinate or a perpendicular to AC, meeting the curve in D, and BE any other ordinate, AD is to BE as the force at A to the force at B, then will twice the area ABED be equal to the square of the velocity which the body has acquired in B. If, therefore, the velocity at B be v , that at the middle point G being c , $v = c \sqrt{\frac{AB}{BC}}$, by hypothesis, and

therefore $2ABED = c^2 \cdot \frac{AB}{BC}$; and since $AB = AC - BC$, $2ABED = c^2 \cdot \frac{AC - BC}{BC} = c^2 \left(\frac{AC}{BC} - 1 \right)$. For the

same reason $2AbED = c^2 \left(\frac{AC}{bC} - 1 \right)$, and therefore the difference of these areas, or $2BbE$, that is, $2EB \times Bb = c^2 \left(\frac{AC}{bC} - \frac{AC}{BC} \right) = c^2 \cdot \frac{AC \cdot Bb}{BC^2}$. Wherefore, dividing

by Bb , $2EB = c^2 \cdot \frac{AC}{BC^2}$; or $EB = c^2 \cdot \frac{AC}{BC^2}$; now c^2 and

AC are given, therefore EB is inversely as BC^2 , that is, the centripetal force at B is inversely as the square of BC , the distance from the centre of force. *In the planetary system, therefore, the force with which any planet gravitates to the sun varies in the inverse ratio of the square of the distance of the planet from the sun's centre.*

10. The line CG is the same with the mean distance of the planet, in an orbit of which AC is the length of the transverse axis, and if the gravitation at that distance = F , and the mean distance itself = a , $F = c^2 \cdot \frac{a}{a^3} = \frac{c^2}{a}$, or $aF = c^2$.

Let it next be required, the elliptic orbit of a planet being given, to find the time in which the planet will revolve round the sun.

If a be the mean distance, or the semitransverse axis, b the semiconjugate, then πab = the area of the orbit. But as c is the velocity at the mean distance, or the elliptic arch which the planet moves over in a second when it is at D, the vertex of the conjugate axis, therefore $\frac{1}{2}bc$ is the area described in that second by the radius vector;

and since this area is the same for every second of the planet's revolution, therefore the area of the orbit divided by $\frac{1}{2}bc$ will give the number of seconds in which the re-

volution is completed, which is therefore $= \frac{\pi ab}{\frac{1}{2}bc} = \frac{2\pi a}{c}$, or since $c^2 = aF$, the time of a revolution $= \frac{2\pi a}{\sqrt{aF}} = 2\pi \sqrt{\frac{a}{F}}$.

11. Hence it is easy to compare the times of the revolutions of any two planets of which the mean distances are known. Let t and t' be the times of revolution for two different planets, of which the mean distances are a and a' , and the gravitation at those distances F and F' ,

and, by what has just been shown, $t : t' :: \frac{a^{\frac{1}{2}}}{F^{\frac{1}{2}}} : \frac{a'^{\frac{1}{2}}}{F'^{\frac{1}{2}}}$, or

$t^2 : t'^2 :: \frac{a}{F} : \frac{a'}{F'}$. But $F : F' :: a^2 : a'^2$, by what is already

shown (Art. 9), therefore $t^2 : t'^2 :: \frac{a}{a^2} : \frac{a'}{a'^2}$, or $t^2 : t'^2 :: a^3 : a'^3$, that is, *the squares of the times of revolution of any two planets are as the cubes of their mean distances from the sun.* Thus the third law of Kepler is explained by the conclusions deduced from the other two.

12. The share which this third law has in establishing the principle of universal gravitation does not seem to have been always clearly apprehended. From the elliptical orbit of a planet, it is fairly inferred that, over all the circumference of that orbit, gravitation is inversely as the square of the distance from the centre of the sun.

That force is shown to be $\frac{c^2 a}{x^2}$ (x being the distance from the centre of force), and the same is true of every individual planet; but whether $c^2 a$ was a constant quantity, or one which retained the same value through the whole planetary system, could not be known without comparing the periods of different planets with their distances from the sun. It was indeed highly probable that $c^2 a$ was a given quantity, or the same for every part of our system; but it could not be considered as a thing demonstrated till the evidence of the third law was introduced.

13. These laws hold of the secondary planets relatively to their primary, just as with the primary planets relatively to the sun. Each system of secondary planets, however, has a different numerator to the fraction which expresses gravity; that is, the quantity $c^2 a$ is the same for all the satellites of Jupiter, but it is a different quantity from that which belongs to the satellites of Saturn, and different from that which belongs to the primary planets. The quantity $c^2 a$ seems therefore to depend on the central body of each system of planets, and the precise nature of this connection requires to be farther examined into.

14. Let the centripetal force tending to a given centre S be inversely as the squares of the distances, and let the intensity of that force at any given distance from the centre be also given; then, if a body be projected from a given point, with a given velocity, and in a given direction, it is required to determine the conic section which it will describe.

Let the semitransverse, or the mean distance to be found, = a , the semiconjugate = b , the velocity at the distance $a = c$, and at the given distance d let the centripetal force = f ; and first let the direction of the initial motion be at right angles to the radius vector, so that the point of projection is either the higher or the lower apsis. Let the velocity of the projection = v , and the radius vector at the point of projection = r .

Because the areas described in equal times are equal,

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of revolution; it has been shown that $t = \frac{2\pi a^{\frac{3}{2}}}{df^{\frac{1}{2}}} = \frac{2\pi a^{\frac{3}{2}}}{m^{\frac{1}{2}}}$,

and consequently $t : t' :: \frac{a^{\frac{3}{2}}}{m^{\frac{1}{2}}} : \frac{a'^{\frac{3}{2}}}{m'^{\frac{1}{2}}}$, and $m : m' :: \frac{a^3}{t^2} : \frac{a'^3}{t'^2}$.

The masses, therefore, of any two planets are as the cubes of the mean distances at which their satellites revolve, divided by the squares of the periodic times of those satellites.

26. In this way the masses of the four planets which have satellites may be compared with one another, and with the mass of the sun.

When this calculation is undertaken with the most correct data, it is found that, making

Mass of the Sun.....	1
that of the Earth.....	$\frac{1}{354936}$
of Jupiter.....	$\frac{1}{1070.5}$
of Saturn.....	$\frac{1}{3512}$
of Uranus.....	$\frac{1}{17918}$

Or if we make the mass of the Earth 1, that of the Sun = 329630, of Jupiter 330.6, of Saturn 101.06, and of Uranus 20.3. From this also may be derived the densities of the sun and of the four planets just mentioned. Seen from a distance equal to the mean radius of the earth's orbit, the diameter of the sun subtends an angle of 1923", that of the earth would subtend 17".4, of Jupiter 186".8, of Saturn 177".7, and of Uranus 74". The real diameters, therefore, are in the proportion of these numbers, and the bulk in the proportion of their cubes. By dividing the quantities of matter by the bulks, we have the densities; and if that of the earth be 4.713, which is its mean density, that of water being = 1, then

Density of the Sun.....	= 1.1775
of the Earth.....	= 4.713
of Jupiter.....	= 1.1678
of Saturn.....	= 0.4055
of Uranus.....	= 1.0348

The mean density of the earth, in respect of water, is here taken from the experiments made at Scheshallien. (*Phil. Trans.* 1811, p. 376.)

27. It has been already observed, that because action is always accompanied by an equal re-action, when the sun attracts a planet, the planet also attracts the sun, and that the velocities impressed on the bodies by their mutual attraction are in the inverse ratio of their masses.

In consequence of this mutual action the sun and the planet must both move, and must describe orbits about their common centre of gravity, the only point which the mutual action of those bodies has no tendency to put in motion.

In the solar system, therefore, the centre of gravity of the whole is the focus about which all the orbits are described. Thus, if C be that centre (fig. 117), S the sun, and P a planet; while P describes the elliptic arch PP' about C, S describes the arch SS' similar to PP', and having to it the ratio that SC has to CP, or the ratio which the mass of the planet has to the mass of the sun.

The true orbits, therefore, are all described about the same immovable point; but the orbit of any of the planets may be referred to the sun as a centre, by supposing a body placed in that centre equal to the sum of the masses of the sun and of the planet. This is true, because the bodies appear to approach one another, or to recede from one another, with a force that is equal to the sum of the forces with which they tend towards their centre of gra-

vity. Thus, if S denote the mass of the sun, and E that of the earth, the distances from the centre being CP and CS, the orbit which each of the two bodies will appear to describe round the other, is that which would be described about an immovable centre C, with a centripetal force

$$= \frac{S+E}{SP^2}.$$

Thus we have arrived at the knowledge of the principle of UNIVERSAL GRAVITATION, a power which pervades all nature, extending to an unlimited distance, and determining the condition of every body in the universe at any instant, from its state in the former instant, and from the relations in which it stands to all other bodies. Whether this force can be explained upon any principle more general than itself, is yet undecided, though, from the bad success which has hitherto attended all attempts towards that object, it seems probable that such explanation is not within the reach of the human understanding. Thus much, however, we know with certainty, that the law of gravity, as just announced, may be considered as a very accurate expression of all the phenomena of the planetary motions.

SECT. II.—Of the Forces which disturb the Elliptic Motion of the Planets.

1. Of the force by which the Sun disturbs the motion of the Moon round the Earth.

28. The motion of the moon in an elliptic orbit round the earth is disturbed by the action of the sun: the gravity of the moon to the earth is increased at the quadratures, and diminished at the syzygies; and the areas described by the radius vector, except near these four points, are never exactly proportional to the times.

Let ADBC (fig. 118) be the orbit, nearly circular, in which the moon M revolves, in the direction CADB, round the earth E. Let S be the sun, and let SE, the radius of the earth's orbit, be taken to represent the force with which the earth gravitates to the sun.

Then $\frac{1}{SE^2} : \frac{1}{SM^2} :: SE : \frac{SE^3}{SM^2}$ = the force by which the sun

draws the moon in the direction MS. Take $MG = \frac{SE^3}{SM^2}$,

and let the parallelogram KF be described, having MG for its diagonal, and having its sides parallel to EM and ES. The force MG may be resolved into the two, MF and MK, of which MF, directed towards E, the centre of the earth, increases the gravity of the moon to the earth, and does not hinder the areas described by the radius vector from being proportional to the times.

The other force MK draws the moon in the direction of the line joining the centres of the sun and earth. It is, however, only the excess of this force above the force represented by SE, or that which draws the earth to the sun, which disturbs the relative position of the moon and earth. This is evident, for if KM were just equal to ES, no disturbance of the moon relatively to the sun could arise from it. If, then, ES be taken from MK, the difference HK is the whole force in the direction parallel to SE, by which the sun disturbs the relative position of the moon and earth. Now, if in MK, MN be taken equal to HK, and if NO be drawn perpendicular to the radius vector EM produced, the force MN may be resolved into two, MO and ON, the first lessening the gravity of the moon to the earth; and the second, being parallel to the tangent of the moon's orbit in M, accelerates the moon's motion from C to A, retards it from A to D, and so alternately in the other two quadrants.

Thus the whole solar force directed to the centre of

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29. The analytical values of these forces must be found if a more exact estimate is to be made of their effects. Let SE, considered as constant, $= a$; EM, the radius vector of the moon's orbit, $= r$; the angle CEM $= \phi$; the mass of the sun $= m$. The force SE, then, which retains the earth in its orbit, is $\frac{m}{a^2}$, and the sun's force in the di-

rection SM, if ML be drawn perpendicular to ES, is $\frac{m}{SM^2}$

$$= \frac{m}{SL^2 + LM^2} = \frac{m}{(a - r \sin \phi)^2 + r^2 \cos^2 \phi} = \frac{m}{a^2 - 2ar \sin \phi + r^2}.$$

The part of this force, which is in the direction ES or MK, is therefore $\frac{ma}{(a^2 - 2ar \sin \phi + r^2)^{\frac{3}{2}}}$. By raising the

denominator to the power $-\frac{3}{2}$, rejecting the terms which involve the higher powers of r , and multiplying ma by those that are left, the force MK comes out $= \frac{m}{a^2} \left(1 + \frac{3r}{a} \sin \phi\right)$

nearly. Taking away from this ES or MH $= \frac{m}{a^2}$, there remains the force MN $= \frac{m}{a^3} \times 3r \sin \phi$.

Hence the force MO $= \frac{m}{a^3} \cdot 3r \sin^2 \phi$; and the force NO at right angles to the radius vector $= \frac{m}{a^3} \cdot 3r \sin \phi$

$\times \cos \phi = \frac{m}{a^3} \cdot \frac{3r}{2} \sin 2\phi$; also the force MF $= \frac{mr}{a^3}$, rejecting such terms as involve the square and higher powers of r . Therefore MF—MO, or the whole solar force increasing or diminishing at any point, the moon's tendency to the earth is $\frac{mr}{a^3} (1 - 3 \sin^2 \phi)$.

30. At the quadratures where ϕ vanishes, this force is $\frac{mr}{a^3}$, and is affirmative, increasing the moon's gravity to the earth. At a certain point, between the quadratures and the syzygies, when $3 \sin^2 \phi = 1$, or $\sin \phi = \frac{1}{\sqrt{3}}$, that is, when $\phi = 35^\circ 15' 5''$, the same force becomes equal to 0, and at this point in each quadrant the moon's gravity to the earth is neither increased nor diminished. From these points to the conjunction and opposition, as $\sin \phi$ increases, the quantity $1 - 3 \sin^2 \phi$ is negative, and the moon's gravity to the earth suffers a diminution. At the opposition and conjunction $\sin \phi = 1$, and therefore the disturbing

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The mean quantity of the force which is thus continually directed to or from the centre of the earth may also be easily computed. Since for any point in the moon's orbit, where the radius vector makes the angle ϕ with the line of the quadratures, this force $= \frac{mr}{a^3} (1 - 3 \sin^2 \phi)$; multiplying by $\dot{\phi}$, we have $\frac{mr}{a^3} (\dot{\phi} - 3\dot{\phi} \sin^2 \phi)$, the fluent of which $= \frac{mr}{a^3} \left(-\frac{1}{2} \phi + \frac{3}{2} \sin \phi \cos \phi\right)$, and this, when ϕ is an entire circumference or four right angles, is $\frac{mr}{a^3} \times -\frac{\pi}{2}$. This is the sum of the forces for an entire revolution, and when divided by π , gives the mean force $-\frac{mr}{2a^3}$, which being negative, shows that the solar force, on the whole, diminishes the gravitation of the moon to the earth.

Thus it appears, that at the quadratures the gravity of the moon to the earth is increased by a quantity equal to the mass of the sun, multiplied into the radius of the moon's orbit, and divided by the cube of the sun's distance from the earth: at the syzygies it is diminished by twice this quantity; and the effect on the whole is a diminution by one half of the same quantity.

If $\frac{mr}{a^3}$ be reduced to its numerical value, supposing the moon's gravitation to the earth to be 1, it is found $= \frac{1}{174}$ nearly. Hence the mean disturbing force of the sun is nearly $= \frac{1}{583}$ of the moon's gravity to the earth.

31. From the disturbing force of the sun arise two kinds of inequalities which affect the lunar motions; the one kind affects the form and position of the orbit of that planet, the other immediately affects the motion of the planet in the orbit. When any of these inequalities is expressed numerically, the measure of it so obtained is, in the language of astronomy, called an *Equation*.

32. The line in which the plane of the moon's orbit cuts the ecliptic is called the line of the nodes; and this line is subject to change its position continually, in such a manner as to go back annually $19^\circ 19' 42'' \cdot 3$. The way in which this effect is produced may be thus conceived. That part of the solar force which is parallel to the line joining the centres of the sun and earth, is not in the plane of the moon's orbit, except when the sun itself is in that plane, or when the line of the nodes, being produced, passes through the sun. In all other cases it is oblique to the plane of the orbit, and may be resolved into two forces, one of which is at right angles to that plane, and is directed towards the ecliptic. This force of course draws the moon continually towards the ecliptic, or produces a continual deflection of the moon from the plane of her own orbit towards that of the earth. Hence the moon meets the plane of the ecliptic sooner than it would have done if that force had not acted. At every half-revolution, therefore, the point in which the earth meets the ecliptic advances in a direction contrary to that of the moon's motion, or contrary to the order of the signs. This retrograde motion is such that, in its mean quantity, it amounts to $19^\circ 19' 42'' \cdot 3$ in a year. The manner of de-

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$$= (1^\circ 20' 29''.9) \sin. (2(\odot - \ominus) - a)$$

where $\odot$ is the mean longitude of the moon, $\ominus$ that of the sun, and a the mean anomaly of the moon counted from the perigee.

38. The moon's variation is an inequality which was discovered by Tycho, and found to depend on the angular distance of that planet from the sun. It is derived from that part of the sun's disturbing force which is at right angles to the radius vector, and which accelerates the motion of the moon from the quadratures to the syzygies, and retards it from the syzygies to the quadratures. The effect of this force is found, from the theory of gravity, to be represented by three terms, which, if Δ be the angular distance of the moon from the sun, are,

$$\begin{aligned} &+ (35' 41''.9) \sin. 2 \Delta \\ &+ (0' 2'') \sin. 3 \Delta \\ &+ (0' 14'') \sin. 4 \Delta. \end{aligned}$$

39. The lunar inequality, called the annual equation, arises from the variation of the sun's disturbing force according to the place which the earth occupies in its orbit. It is shown above that the sun's disturbing force is, *ceteris paribus*, as the cube of his distance from the earth; so that when the earth is in its perihelion this force is the greatest, and at the aphelion the least, its effect varying at the same rate with the equation of the sun's centre, or having everywhere the same ratio to that equation. Hence this equation is nearly $(11' 12'') \times \sin.$ sun's mean anomaly, with a contrary sign to the equation of the sun's centre.

40. These inequalities are all phenomena which were observed before the explanation of them was known. To them may be added a fourth inequality, known by the name of the moon's acceleration. It appeared to astronomers as a continual increase in the velocity of the moon, or in the rate of her mean motion, amounting to about $10''$ in a century, and its effect, like that of all other constant accelerations, accumulating as the squares of the times. It did not seem to be periodical, like the other lunar inequalities, but to be a constant increase of the velocity, and a corresponding diminution of the periodical time of the moon, which must in the end change entirely the relation of that body to the earth.

It is but within these few years that Laplace discovered it to be a periodic inequality, though requiring, in order to accomplish the series of its changes, a length of time which science has not yet ventured to calculate. For many centuries to come it may be expressed by this formula, taking n to denote the number of centuries reckoned from the year 1700, viz.

$$10''.7232 \times n^2 + 0''.019361 \times n^3.$$

The first term includes all that was known from observation previously to the discovery of Laplace. This, however, must be considered not as the true form of the equation, which must include the sines or cosines of certain angles, but merely a provisional formula, to serve till the true one can be rigorously assigned.

This inequality has in its cause a great affinity to the annual equation.

Whatever changes the form of the earth's orbit, has an effect on the disturbing force of that body on the moon, which is in the inverse ratio of the cube of the distance

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41. All these inequalities have been pointed out by observations, and have been explained in the most satisfactory manner by the principle of universal gravitation. But when all these were reduced into equations and arranged in tables, yet the places of the moon calculated from them were never quite exact; and there seemed a cause of error or a mass of small inequalities unknown in their magnitude and form, to which this inaccuracy was to be ascribed, and which operated, as it may be said, like a mist which concealed the true place of the moon from the calculator, and prevented his results from agreeing completely with those of the observer. The most likely way to discover these inequalities, if they arose from gravity, was to push the approximation to the moon's place still farther, and to try if the terms hitherto neglected in the approximation would not, when taken into account, afford a complete analysis of the circle of confusion which might be said to surround the moon on all occasions.

The problem on which mathematicians now entered, and which Clairaut, already mentioned, Euler, and D'Alembert, all three resolved nearly about the same time, has been called the *Problem of Three Bodies*. The thing proposed is, three bodies which attract one another with forces directly as their quantities of matter, and inversely as the squares of their distances, being given, and any motions whatever being impressed on them, to find the orbits which they will describe round their common centre of gravity. It is, however, only in certain cases that this general problem admits of solution, and one of these is, when one of the bodies is at a vast distance from the other two. This is exactly the case with the moon and earth in respect of the sun, the orbit of the earth being nearly the same as if there only existed the sun and earth, and the orbit of the moon relative to the earth being nearly the same if there were only the moon and earth. This solution of the problem, however, in this direct way, leads to far more exact conclusions than can be obtained from the more simple but more indirect method which Newton followed. The general view which leads to the most exact estimate of the merit of the two solutions is, that the motions of the moon, when analytically and fully expressed, necessarily form a number of different series, each of which converges with more or less rapidity. The prosecution of the direct method allows the terms of these series to be computed to an indefinite extent, or till the quantities omitted are too small to affect observation. The method of Newton can go no farther than to compute the first, or at most a few of the leading terms of each of the series. Its accuracy is therefore limited; that of the other knows no limits. Though this be a true estimate of the value of the methods, yet that of the original inventor possesses infinite merit, as having first led the way to this arduous investigation, and as still serving to carry the imagination better along with it than the other, and to keep the mechanical principles more directly in view.

The complete solution of the problem of the *three bodies* has accordingly discovered a great number of new equations, each individually small, which would sometimes nearly destroy one another, and, at other times, having many of them the same sign, would accumulate to a considerable amount. This was the triumph of the theory, and the strongest evidence of its truth. The effect

Physical Astronomy. of these irregularities varied so much, and depended on so many elements, that it may be doubted whether the most accurate and most constant observation would ever have enabled astronomers to discover their precise quantities, and to separate them from one another.

The tables of the moon, in the state to which they are now brought, contain twenty-eight equations for the longitude, twelve for the latitude, and thirteen for the horizontal parallax of the moon. Of the first of these, twenty-three have been deduced from theory alone; of the second, nine; and of the third, eleven. This applies to the tables of Burg; those since published by Burckhardt contain more equations, and are still more accurate.

2. *Of the Disturbance in the Motion of the Primary Planets, produced by their action on one another.*

42. It is evidently necessary, in this inquiry, to know the quantities of matter in the different planets, or, which comes to the same, the intensity of the attraction of each at a given distance from its centre. With respect to those planets which have satellites, the Earth, Jupiter, Saturn, and Uranus, their masses or quantities of matter have been already determined. The masses of Venus and Mars have been estimated by Laplace, from the effects which they appear to produce on the earth's motion. The mass of Mercury has been estimated on the supposition that the densities of that planet and of the earth are inversely as their mean distances from the sun. This law holds with respect to the Earth, Jupiter, and Saturn, and analogy renders it probable that the same law includes the other planets. Thus, the mass of the Sun being 1, that of Mercury is $\frac{1}{2025810}$, of Venus $\frac{1}{405871}$, and of Mars $\frac{1}{2546320}$; the masses of the other planets being as already stated.

43. The effects of the action of the planets on one another is more difficult to be investigated than the effects of the sun's action on the moon, because the disturbing forces are not only more numerous, but because the distance of the disturbing from the disturbed body is not so great that the quantities divided by higher powers of that distance can be so safely rejected. The general principle, however, according to which the solar action on the moon was resolved into forces either in the direction of the radius vector or at right angles to it, is applicable to both questions.

Thus, supposing P and P' (fig. 119) to be two planets revolving in orbits, nearly circular, about the sun at S; in order to find how the motion of P' is affected by the action of P, let PP', PS, and P'S be drawn, and let the line A denote the force with which P attracts a particle of matter at the distance PS, then the force with which it attracts a particle at the distance PP', will be $A \times \frac{PS^2}{P'P^2}$. Let

$PR = A \times \frac{PS^2}{P'P^2}$; and if PR be resolved into two forces, PM and PN, the one in the direction of the radius vector PS, and the other parallel to PS, take NO = A; then the remaining forces OP' and PM are those which disturb the motion of P', as was proved in the case of the moon. The former of these, OP', may be resolved into OQ and PQ, of which PQ diminishes the gravity of the planet to the sun, and OQ accelerates its motion in a direction perpendicular to the radius vector. Therefore, as the force PM always increases the planet's gravity to the sun, PM—PQ is the whole force increasing or diminishing the gravity of P' to S; and the force directly employed in increasing or diminishing the angular motion of P about S, is OQ or P'T. The analytical values of these quantities may be found, as in the theory of the moon, though not with equal simplicity, because SP cannot always be supposed great in respect of SP'.

Physical Astronomy. 44. In consequence of these actions, the orbit of every planet may be considered as an ellipsis, which is undergoing slowly certain changes in its form, magnitude, and position, or in what are called its elements. By the elements of the orbit of any heavenly body, are meant the quantities that determine the position and magnitude of that orbit, viz. the position of the line of the nodes, the inclination of the plane of the orbit to the plane of the ecliptic, the position of the line of the apsides, the eccentricity, and the mean distance. These are all quantities independent of one another, and from them may be deduced all other circumstances with respect to the elliptic orbit. Of these five elements, which would be invariable if the planet only gravitated to the sun, all except the mean distance are subject to slow but perpetual changes.

45. The line of the nodes, in every one of the planets, has a retrograde angular motion, which goes on continually, and of which the amount, when calculated as due to each planet, agrees very well with observation. The plane of the orbit also varies its inclination, by certain small periodical changes, which alternately increase and diminish it, as in the case of the moon. The line of the apsides, from the same cause as in the planet just mentioned, has a continued motion forward, or according to the order of the signs. Thus, in Mercury the node goes back about 7".82 annually. The aphelion goes forward about 5".84 in a year, and the inclination of the orbit in the course of a century increases about 18".18, which, in the course of succeeding ages, will be compensated by an equal diminution, so as to preserve it always nearly of the same quantity. In the same planet the equation of the centre, which depends on the eccentricity, increases about 1".6 in a century, indicating a small increase of eccentricity. These variations in the orbit of Mercury arise from the action of Venus, the Earth, Mars, Jupiter, and Saturn; the effects of the first of these planets, on account of its vicinity, being by much the most considerable. The mean distance, however, of Mercury from the Sun, does not, any more than that of the other planets, undergo any change whatever.

46. Similar conclusions apply also to the orbit of Venus. The orbit of the earth also is subject to similar changes, the line of the apsides moving forward annually at the rate of 11".8, in respect to the fixed stars. The earth's eccentricity is also diminishing, and the secular variation of the greatest equation of the centre is — 17".66.

The motion of the earth is subject to another inequality on account of the action of the moon; for, to speak strictly, it is not the centre of the earth, but the centre of gravity of the moon and earth, which describes equal areas in equal times about the centre of the sun. It is evident that, on this account, the earth will be sometimes advanced before, and sometimes will fall behind, the point which describes the circumference of the ellipsis, in conformity with the general law of the planetary motions. From the same cause also, as the moon does not move in the plane of the ecliptic, the earth will be forced out of that plane, in order to preserve a position diametrically opposite to the moon. These irregularities, however, are inconsiderable. By observers on the earth's surface, they are transferred to the sun, but in an opposite direction. The sun, therefore, has a motion in longitude, by which he alternately advances before the point which describes the elliptic orbit in the heavens, and falls behind it; and also a motion in latitude, by which he alternately ascends above and descends below the plane of the ecliptic. As the mass of the moon, however, is not more than $\frac{1}{79}$ part of that of the earth, the distance of the centre of gravity of the moon and earth from the centre of the latter must be

Physical Astronomy. have so altered the original orbit as to render the comet for a time visible from the earth; and that the same cause may have so changed it, after one revolution, as to restore the comet to the same region in which it had formerly moved. This is the greatest instance of disturbance which has yet been discovered among the bodies of our system, and furnishes a very happy, as well as an unexpected, confirmation of the theory of gravity.

Though the comets are so much disturbed by the action of the planets, yet it does not appear that their reaction produces any sensible effect. The comet of 1770 came so near to the earth as to have its periodic time increased by 2.246 days, according to Laplace's computation; and if it had been equal in mass to the earth it would have augmented the length of the year by not less than two hours and forty-eight minutes. It is certain that no such augmentation took place, and therefore that the disturbing force by which the comet diminished the gravity of the earth is insensible, and the mass of the comet, therefore, less than $\frac{1}{300}$ th of the mass of the earth. The same comet also passed through the system of the satellites of Jupiter without causing any derangement of their motions. Hence it is reasonable to conclude, that no material or even sensible alteration has ever been produced in our system by the action of a comet.

3. Of the disturbances which the satellites of Jupiter suffer from their action on one another.

51. The same resolution of the forces by which one satellite acts upon another, into two, one directed to the centre of the primary, and the other at right angles to it, serves to explain the irregularities which had been observed in their motions, and to reduce under known laws several other inequalities, of which the existence only is indicated by observation.

An instance of this we have in the very remarkable relation which takes place between the mean motions of the first three satellites; the mean motion of the first satellite, together with twice the mean motion of the third, being equal to three times the mean motion of the second. Laplace has shown that, if the primitive mean motions of these satellites were nearly in this proportion, the mutual action of these bodies on one another must in time have brought about an accurate conformity to it.

The first satellite moves nearly in the plane of Jupiter's equator, and has no eccentricity, except what is communicated from the third and fourth, the irregularities of one of these small bodies producing similar irregularities in those that are contiguous to it. The first satellite has, beside, an inequality, chiefly produced by the action of the second, and circumscribed by a period of 437.659 days.

52. The orbit of the second satellite moves on a fixed plane, to which it is inclined at an angle of $27^{\circ} 13'$, and on which its nodes have a retrograde motion, so that they complete a revolution in 29.914 years. The motion of the nodes of this satellite is one of the principal data used for determining the masses of the satellites themselves, which are so necessary to be known for computing their disturbances. This satellite has no eccentricity but that which it derives from the action of the third and fourth. The third satellite moves on a fixed plane, to which it is inclined at an angle of $12^{\circ} 20'$, and its nodes make a tropical revolution backwards in 141.739 years. The equator of Jupiter is inclined to the plane of his orbit at an angle of $3^{\circ} 5' 30''$. The fixed planes on which the planes of the orbits move are determined by theory, and could not have been discovered by observation alone.

The orbit of the third satellite is eccentric, but appears to have two distinct equations of the centre; one which

really arises from its own eccentricity, and another which theory shows to be an *emanation* from the equation of the centre of the fourth satellite. The first equation is referable to an apsis which has an annual motion of $2^{\circ} 36' 39''$ forward in respect of the fixed stars; the second equation is referable to the apsides of the fourth satellite.

These two equations may be considered as forming one equation of the centre, referable to an apsis that has an irregular motion. The two equations coincided in 1682, and the sum of their *maxima* was $13' 16''$. In 1777 the equations were opposed, and their difference was $5' 6''$.

The two last inequalities were perceived by Mr Wargentin, by observation alone; but their exact amount, and the law which they observe in their changes, he could not discover. The orbit of the fourth satellite moves on a fixed plane, to which it is inclined at an angle of $14' 58''$; and its nodes complete a sidereal revolution backward in 531 years. The fixed plane on which the orbit moves is inclined at an angle of $24' 33''$ to the equator of Jupiter; the orbit is sensibly elliptical, and its greater axis has an annual motion of $42' 58''.7$. The motion of this axis is one of the principal data from which the quantities of matter of the different satellites have been determined.

If the mass of Jupiter be supposed unity, the mass of the 1st satellite = .0000173281

of the 2d = .0000232355

of the 3d = .0000884972

of the 4th = .0000426591

If the mass of the earth be supposed unity, that of the third satellite will be found = .027337; and as the mass

of the moon is $\frac{1}{79.89}$, = .012517, the quantity of matter in the third satellite is about twice as great as that in the moon. The fourth satellite is therefore nearly equal to the moon, the second about one half, and the first somewhat more than one third.

53. The general result of this investigation concerning the inequalities in the motion of the planets, both primary and secondary, is, that in every one of these orbits two things remain secure against all disturbance, the mean distance and the mean motion, or, which is the same, the transverse axis of the orbit, and the time of the planet's revolution. Another result is, that all the inequalities in the planetary motions are periodical, and observe such laws that each of them, after a certain time, runs through the same series of changes. This last conclusion follows from the fact, that every inequality is expressed by terms of the form $A \sin. nt$ or $A \cos. nt$, where A is a constant co-efficient, and n a certain multiplier of t the time, so that nt is an arch of a circle, which increases proportionally to the time. Now, in this expression, though nt is capable of indefinite increase, yet, since nt never can exceed the radius, or 1, the maximum of the inequality is A . Accordingly, the value of the term $A \sin. nt$ first increases from 0 to A , and then decreases from A to 0; after which it becomes negative, extends to $-A$, and passes from thence to 0 again. If, when the inequality was affirmative, it was an addition to the mean motion, when negative it will become a diminution of it; and the sum of all these increments and decrements, after nt has passed over an entire circumference, or 360° , is equal to 0; so that at the end of that period the planet is in the same position as if it had moved on regularly all the while at the rate of the mean motion. As this happens to every one of the inequalities, the deviation of the system from its mean state can never go beyond certain limits, each inequality in a certain course of time destroying its own effect.

It would be far otherwise if into the value of any inequalities a term entered of the form $A \times nt$, $A \tan. nt$,

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$\frac{A}{\sin. nt}$

The inequalities so expressed would continually increase with the time, so as to go beyond any assignable limit, and of consequence to destroy entirely the order of any system to which they belonged.

Lagrange and Laplace, who discovered and demonstrated that no such terms as these last can enter into the expression of the disturbances which the planets produce by their action on one another, made known one of the most important truths in physical science. They proved that the planetary system is stable, and that it does not involve any principle of destruction in itself, but is calculated to endure for ever, or till the action of an external power shall put a period to its existence. After the knowledge of the principle of gravitation, this may be fairly considered as the greatest discovery to which men have been led by the study of the heavens.

The accurate compensation, just remarked, depends on three conditions, belonging to the primitive or original constitution of our system, but not necessarily determined, as far as we know, by any physical principle. The first of these conditions is, that the eccentricities of the orbits are all inconsiderable, or contained within very narrow limits, not exceeding in any instance one tenth or one eighth part of the mean distance. The second condition is, that the planets all move in the same direction, or from west to east. This is true both of the primary and secondary planets, with the exception only of the satellites of Uranus, which may be accounted retrograde; but their planes being nearly at right angles to the orbit

of their primary, the direction of their motion, whether retrograde or otherwise, can have little effect. Lastly, the planes of the orbits of the planets are not much inclined to one another. This is true of all the larger planets, though it does not hold of some of the new and smaller ones; of which, however, the action on the whole system must be altogether insensible.

Unless these three conditions were united in the constitution of the solar system, terms of the kind just mentioned, admitting of indefinite increase, might enter into the expression of the inequalities, which would indicate a gradual and unlimited departure from the original order and constitution of the universe. Now, the three conditions just enumerated do not necessarily arise out of the nature of motion, or of gravitation, or from the action of any physical cause with which we are acquainted. Neither can they be considered as arising from chance; for the probability is almost infinite to one, that, without a cause particularly directed to that object, such a conformity could not have arisen in the motions of thirty-one different bodies, scattered over the whole extent of the solar system. *The only explanation, therefore, which remains is, that all this is the work of intelligence and design, directing the original constitution of our system, and impressing such motions on the parts as are calculated to give stability to the whole.* (N.)

For some further discussions connected with *Physical Astronomy*, see the articles COMETS; EARTH, *Figure of*; PRECESSION of the EQUINOXES; and TIDES.

PART IV.

PRACTICAL ASTRONOMY.

INTRODUCTION.

PRACTICAL ASTRONOMY may be considered as comprehending the observations which must originally have been made to determine the facts which have now been embodied in a system; also those which are continually making for its farther extension and improvement;—the observations which are required to make the science useful in the affairs of life; and the rules and calculations which must be applied to the observations, to obtain from them the required result.

The division of labour in this, as in other subjects, has been attended with advantage. One class of astronomers now survey the heavens by telescopes of more or less power. These, within the last fifty years, have enriched the science by the discovery of five new planets in addition to the six known from the most remote ages. The late Sir William Herschel took the lead in this noble labour, and he has been followed by many others. By their exertions various comets have been observed; and the periodic times and orbits of three have now been determined with such certainty as to enable us to predict their return. A second class observe the heavenly bodies with instruments which combine increased powers of seeing, with the means of measuring minute angular distances or considerable angles with great accuracy. The established national observatories, and some private observatories, conducted with not less zeal and intelligence, are engaged in this important labour. These employ transit instruments, clocks, mural or meridian circles, quadrants, equatorial or azimuth and altitude instruments, of the best workmanship. Their object is less to add new facts than to improve and extend those which are already known.

By the observations made in observatories, the science is continually advancing towards perfection; but, like all knowledge founded on observation, there will ever be room for further improvement.

Although it is only a few individuals, comparatively speaking, that can possess telescopes of such power as to give reasonable hopes of extending astronomical knowledge by the discovery of new phenomena, yet, by the liberality of governments, the united efforts of learned bodies, and the fortunate possession of leisure, pecuniary means, and zeal for the improvement of the science evinced by some private gentlemen, telescopes of extraordinary dimensions and excellence have been constructed, and considerable additions have of late years been made to our knowledge of the heavens in regions almost beyond the flight of human imagination.

The great instruments, such as are placed in national observatories, are also in general beyond the reach of private astronomers; yet a few wealthy amateurs of the science have rivalled these establishments, both in the acquisition of instruments and in their application. With instruments of an inferior construction little can be done towards improving the primary elements of astronomy, because the results they give are less correct and less to be depended on than those obtained by superior instruments. When the measure of an angle is determined to the accuracy of a second, it is of no use to have another measure which may err as much as ten seconds. However, it cannot be doubted that the best instruments now employed will in time be superseded by others more perfect. After a certain degree of accuracy has been obtained, it is only by slow degrees and much labour that we can go beyond it; and then, like differentials of different orders, every

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$$\cos. Z = \cos. \Delta \frac{\cos. (\lambda - \phi)}{\cos. \phi} \dots \dots \dots (1.)$$

2. To find A, we have from spherical trigonometry the formula

$$\cot. A = \frac{\cot. \Delta \sin. \lambda}{\sin. P} - \cot. P \cos. \lambda.$$

Assume $\cot. \psi = \frac{\cot. \Delta}{\cos. P}$, whence $\cot. \Delta = \cot. \psi \cos. P$,

and, by substituting,

$$\begin{aligned} \cot. A &= \cot. P (\cot. \psi \sin. \lambda - \cos. \lambda) \\ &= \cot. P \left(\frac{\cos. \psi \sin. \lambda - \sin. \psi \cos. \lambda}{\sin. \psi} \right), \end{aligned}$$

whence

$$\cot. A = \frac{\cot. P \sin. (\lambda - \psi)}{\sin. \psi} \dots \dots \dots (2.)$$

3. To find V we have

$$\cot. V = \frac{\cot. \lambda \sin. \Delta}{\sin. P} - \cos. \Delta \cot. P.$$

Assume $\cot. \chi = \frac{\cot. \lambda}{\cos. P}$, or $\cot. \lambda = \cot. \chi \cos. P$, then,

by substituting and reducing as above, we have

$$\cot. V = \frac{\cot. P \sin. (\Delta - \chi)}{\sin. \chi} \dots \dots \dots (3.)$$

PROBLEM IV.—Given the declination and zenith distance of a star, and the latitude of the observatory, to determine the hour-angle.

This is the case in the solution of spherical triangles, in which the three sides are given to find one of the angles. The formula, therefore, from which P is computed (see SPHERICAL TRIGONOMETRY) is

$$\tan. \frac{1}{2} P = \frac{\sin. \frac{1}{2} (Z + \lambda - \Delta) \sin. \frac{1}{2} (Z - \lambda + \Delta)}{\sin. \frac{1}{2} (Z + \lambda + \Delta) \sin. \frac{1}{2} (\lambda + \Delta - Z)}.$$

PROBLEM V.—Given the latitude of a place, and the sun's declination, to find, 1st, the time of sunrise; 2d, the sun's amplitude at rising; 3d, the time when the sun is due east; 4th, the sun's altitude when in that position.

In fig. 122 let AZP be the meridian, in which Z is the zenith, and P the pole; let ZO be the prime vertical, and AOB the horizon, A being the south, O the east, and B the north points; let SS' be the part of the parallel described by the sun between his rising and passing the prime vertical, and PS PS' hour circles.

Let L = the latitude of the place = PB,

D = the sun's declination = $90^\circ - PS$,

v = the time from midnight to sunrise = hour angle SPB,

x = the sun's amplitude at rising = OS,

y = the time from midnight to the sun's coming on the prime vertical = hour-angle SPB,

z = the sun's altitude when in the prime vertical = OS'.

In the spherical triangle PBS, right angled at B,

$$\cos. SPB = \frac{\tan. PB}{\tan. PS}, \quad \cos. BS = \frac{\cos. PS}{\cos. PB};$$

and in the spherical triangle PZS', right angled at Z,

$$\cos. ZPS = \frac{\tan. PZ}{\tan. PS'}, \quad \cos. ZS' = \frac{\cos. PS'}{\cos. PZ}.$$

Now PB = L, PZ = $90^\circ - L$, PS = PS' = $90^\circ - D$, BS = $90^\circ - x$, ZS' = $90^\circ - z$; hence we have these four formulæ:

$$\cos. v = \tan. L, \tan. D \dots \dots \dots (1.)$$

$$\sin. x = \frac{\sin. D}{\cos. L} \dots \dots \dots (2.)$$

$$\cos. y = \cot. L, \tan. D \dots \dots \dots (3.)$$

$$\sin. z = \frac{\sin. D}{\sin. L} \dots \dots \dots (4.)$$

The hour-angles v and y must be converted into time by allowing 15° to one hour.

PROBLEM VI.—To find how much the rising of the sun or a star is advanced by refraction.

Let ZPB be the meridian (fig. 123), Z the zenith, P the pole, and OB the horizon. Let SS', the parallel described by the sun, meet the horizon in S. Were it not for the effect of refraction, the sun or star would appear to rise at S, and at rising the hour-angle from midnight would be SPB; but it is elevated by refraction (which takes place in a vertical circle), and appears to rise at D, while in fact it is below the horizon at S' somewhere in the vertical circle ZD produced downward, and the time of rising is accelerated by the small angle SPS'.

Let L denote the latitude of the place = $90^\circ - PZ$; D the declination of the star = $90^\circ - PS$; H the hour-angle BPS, reckoned from midnight; r the arc DS of the vertical ZS, the effect of refraction; and x the angle SPS, the acceleration of time of rising.

In the spherical triangle ZPS',

$$\cos. ZS' = \cos. ZP \cos. PS' + \sin. ZP \sin. PS' \cos. ZPS',$$

Now, $\cos. ZS' = \cos. (90^\circ + r) = -\sin. r$,

and $\cos. ZPS' = -\cos. BPS' = -\cos. (H - x)$;

therefore

$$-\sin. r = \sin. L \sin. D - \cos. L \cos. D \cos. (H - x).$$

In like manner, in the triangle ZPS, in which $\cos. ZS = \cos. 90^\circ = 0$,

$$0 = \sin. L \sin. D - \cos. L \cos. D \cos. H;$$

hence, by subtraction,

$$\sin. r = \cos. L \cos. D [\cos. (H - x) - \cos. H],$$

$$\text{and } \cos. (H - x) - \cos. H = \frac{\sin. r}{\cos. L \cos. D};$$

$$\text{but } \cos. (H - x) - \cos. H = 2 \sin. \frac{1}{2} x \sin. \left(H - \frac{x}{2} \right)$$

(ALGEBRA, § 239, D);

$$\text{therefore, } 2 \sin. \frac{1}{2} x \sin. \left(H - \frac{x}{2} \right) = \frac{\sin. r}{\cos. L \cos. D}.$$

Now, x and r being small angles, we may consider

$$2 \sin. \frac{1}{2} x = x, \sin. r = r, \text{ and } \sin. \left(H - \frac{x}{2} \right) = \sin. H.$$

$$\text{We have then } x = \frac{r}{\sin. H \cos. L \cos. D};$$

and here H is determined by the formula

$$\cos. H = \tan. L \tan. D.$$

The value of x just found is only a near approximation; let it be denoted by x', and let $H' = H + x'$, and we shall have more nearly

$$x = \frac{r}{\sin. H' \cos. L \cos. D}.$$

$$\text{Since } \cos. H = \tan. L \tan. D = \frac{\sin. L \sin. D}{\cos. L \cos. D};$$

$$\text{therefore, } \sin.^2 H = \frac{\cos.^2 L \cos.^2 D - \sin.^2 L \sin.^2 D}{\cos.^2 L \cos.^2 D}.$$

$$\begin{aligned} \text{Again, } \cos.^2 L \cos.^2 D - \sin.^2 L \sin.^2 D \\ = (\cos. L \cos. D - \sin. L \sin. D)(\cos. L \cos. D + \sin. L \sin. D) \\ = \cos. (L + D) \cos. (L - D). \end{aligned}$$

Practical Astronomy. Therefore, $\sin.^2 H = \frac{\cos. (L + D) \cos. (L - D)}{\cos.^2 L \cos.^2 D}$, and $x = \frac{r}{\sqrt{[\cos. (L + D) \cos. (L - D)]}}$

The value of r is variable; but in general it is about 33 minutes of a degree, or 132 seconds of time. Therefore the acceleration by refraction is nearly, in time,

$$\frac{132^s}{\sqrt{[\cos. (L + D) \cos. (L - D)]}}$$

PROBLEM VII.—To find the length of the twilight.

Let ZPB (fig. 123) be the meridian, Z the zenith, P the pole, and SDB the horizon. Let S'S be the arc of the parallel described by the sun between the beginning of the twilight, when he is at S', and its end at sunrise, when he reaches the horizon at S.

The twilight begins when DS', the sun's depression below the horizon, is about 18°.

Let a denote the arc, DS the depression, L the latitude of the place = 90° — ZP, D the sun's declination = 90° — PS, H the hour angle SPB (from midnight), x the angle SPS'.

Then, $\cos. ZS' = \cos. ZP \cos. PS' + \sin. ZP \sin. PS' \cos. ZPS'$;

that is, because $\cos. ZS' = -\sin. a$, and $\cos. ZPS = -\cos. SPB$,

$-\sin. a = -\sin. L \sin. D - \cos. L \cos. D \cos. (H - x)$;

hence we obtain

$$\cos. (H - x) = \tan. L \tan. D + \frac{\sin. a}{\cos. L \cos. D}$$

Now, by Problem V. $\cos. H = \tan. L \tan. D \dots \dots (1)$
Let ϕ be such an angle, that

$$\cos. \phi = \frac{\sin. a}{\cos. L \cos. D};$$

Then $\cos. (H - x) = \cos. H + \cos. \phi$
 $= 2 \cos. \frac{1}{2} (H + \phi) \cos. \frac{1}{2} (H - \phi) \dots \dots (2)$

Now H is determined by formula (1); therefore x , the angle described about the pole while the twilight lasts, is determined by formula (2).

PROBLEM VIII.—Given the right ascensions and declinations of two celestial bodies, to compute their angular distance.

Let S and M (fig. 124) be the two stars (for example the sun and moon), and let Z be the zenith, and P the pole of the equator. In the triangle SPM, the side SM represents the angular distance of the two stars; PS and PM are respectively their polar distances, or the complements of their declinations, and therefore given; and the angle SPM is also given, being the difference of ZPS and ZPM, the right ascensions of the given stars. Let PS = Δ , PM = Δ' , the angle SPM = P, and SM, the distance sought, = d . We have then

$$\cos. d = \cos. \Delta \cos. \Delta' + \sin. \Delta \sin. \Delta' \cos. P.$$

Assume $\tan. \phi = \tan. \Delta \cos. P$; then, by substituting and reducing, as in Problem II., we obtain

$$\cos. d = \frac{\cos. \Delta \cos. (\Delta' - \phi)}{\cos. \phi}$$

PROBLEM IX.—To determine the latitude of a place.

1. Of the various methods which are employed for determining the latitude, that which depends on the observation of the double transits, or upper and lower culmination of a circumpolar star, is perhaps the best, being inde-

pendent of the star's declination, and of the effects of aberration and nutation. The accuracy of the result depends, indeed, on the allowance made for refraction; but unless the observed star at the lower culmination passes within 15° or 20° of the horizon, the errors of the tables will be very inconsiderable.

Let Z be the observed zenith distance, and R the refraction of the star at its lower culmination; Z' and R' the same quantities at its upper culmination, and λ the correct zenith distance of the pole, or the co-latitude; then

$$\lambda = \frac{1}{2}(Z + Z') + \frac{1}{2}(R + R').$$

The quantities R and R' must be taken from the tables, regard being had to the state of the barometer and thermometer.

2. Another method of determining the latitude, which, by reason of the facility of observation and computation, is extremely commodious, and therefore much employed, especially by voyagers, depends on observations of the meridional zenith distances of the sun or a star. Let P (fig. 125) be the pole, Z the zenith, C the intersection of the meridian and equator, and S the sun or star; then, l being the required latitude,

$$l = ZC = ZS \pm SC = Z \pm D,$$

according as the star is situated S or S', that is, above or below the equator.

If the star is to the north of the zenith, and above the pole, as at a , then

$$l = ZC = Ca - Za = D - Z,$$

and if below the pole, at a' , then $Ca' = 180^\circ - D$, and

$$l = ZC = Ca' - Za' = 180^\circ - (Z + D).$$

PROBLEM X.—To determine the difference of longitude between two points on the earth's surface.

The different methods which have been proposed for the solution of this problem, one of the most difficult in practical astronomy, are the following: 1st, The eclipses of Jupiter's satellites; 2d, the eclipses of the moon; 3d, the eclipses of the sun; 4th, the occultations of fixed stars by the moon; and, 5th, the comparison of the moon's transits over the meridian with those of certain fixed stars selected for the purpose. Of these five methods, the two first give results affected by many causes of uncertainty; and the third can seldom be practised, because solar eclipses occur very rarely for any given point on the earth's surface. Of the remaining two, the last (which is recommended by Mr Baily) seems entitled to the preference, on account of its being independent of great accuracy in the rate of the clock or the position of the transit instrument.

The difference of the longitudes of the two stations is supposed to be nearly known from the chronometer, or by other means; and the object is to correct or determine the error of the first approximation.

Let A and B be the two stations, of which A is supposed to be the most westerly, and put

τ = the difference (in sidereal time) of the transit of the moon's limb and the star previously agreed on at A;

τ' = the same difference at B;

t = the apparent Greenwich time of the culmination of the moon at A;

t' = the apparent Greenwich time of the culmination of the moon at B;

d = Δ 's true declination } computed for the time

r = Δ 's true radius } t ;

d, r = the same quantities computed for the time t' ;

s = the length of the true solar day in seconds;

m = Δ 's motion in $\angle R$ in half that interval, expressed in seconds of space;

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χ = the assumed difference of longitude, in time;
 $(\chi + e)$ = the correct difference of longitude.

The angle comprised between the two horary circles which pass respectively through the centre and limb of the moon, at the station A, is $\frac{r}{\cos. d'}$, which being reduced

to time, becomes $\frac{r}{15 \cos. d'}$, and expresses the sidereal time in which the moon's semi-diameter passes the meridian.

Hence $\tau \pm \frac{r}{15 \cos. d'}$ is the observed difference of the AR of the star and moon's centre at A, the upper sign being taken when the first or western limb of the moon is observed, and the under when it is the eastern limb, the star being supposed to precede the moon. In the same manner $\frac{r'}{15 \cos. d'}$ is the sidereal time in which the semi-diameter of the moon passes the meridian at B, and $\tau \pm \frac{r'}{15 \cos. d'}$ the observed difference of the AR of the star and moon's centre. We have, therefore, by subtracting these two expressions,

$$(\tau - \tau') \pm \frac{r}{15 \cos. d'} \mp \frac{r'}{15 \cos. d'}$$

for the observed difference of the AR of the moon's centre, during the time elapsed between the two observations. Put this difference equal to Δ , then $\chi + \Delta$ is the difference between t and t' in sidereal time, which becomes $(\chi + \Delta) \frac{8640}{s}$ when expressed in mean solar time.

Hence we have

$$t = t' + (\chi + \Delta) \frac{8640}{s};$$

consequently, when the apparent Greenwich time at one of the observatories is known, it is also known at the other observatory. Now, let a and a' be the moon's AR in space, computed for the times t and t' respectively (taken from the ephemeris); then the formula for the correction of the assumed difference of longitudes will evidently be

$$e = \left\{ 15 \Delta - (a - a') \right\} \frac{s}{2m};$$

and this added to χ gives $\chi + e$, the corrected difference of longitudes.

PROBLEM XI.—To find the meridional zenith distance of the sun (or a star), from observations made near the meridian.

Let P (fig. 124) be the pole, Z the zenith, and S the sun. Make

$l = 90^\circ - PZ$ = the latitude of the place;

$D = 90^\circ - PS$ = the declination;

$P = ZPS$ the hour angle;

$Z = l - D$ = the true zenith distance;

$Z' = ZS$ the observed zenith distance;

$x = Z' - Z$ the correction.

The triangle PZS gives

$\cos. ZS = \cos. ZP \cos. PS + \sin. ZP \sin. PS \cos. ZPS$,
or $\cos. Z' = \sin. l \sin. D + \cos. l \cos. D \cos. P$;

but $\cos. (l - D) = \cos. l \cos. D + \sin. l \sin. D$,

and $\cos. P = 1 - 2 \sin.^2 \frac{1}{2} P$,

therefore,

$$\cos. Z' = \cos. (l - D) - 2 \cos. l \cos. D \sin.^2 \frac{1}{2} P,$$

or $\cos. Z' = \cos. Z - 2 \cos. l \cos. D \sin.^2 \frac{1}{2} P$.

Now, by the trigonometrical formula (ALGEBRA, p. 240),

$$\cos. Z - \cos. Z' = 2 \sin. \frac{1}{2} (Z' - Z) \sin. \frac{1}{2} (Z' + Z),$$

therefore,

$$2 \sin. \frac{1}{2} (Z' - Z) \sin. \frac{1}{2} (Z' + Z) = 2 l \cos. D \sin.^2 \frac{1}{2} P. \quad \text{Practical Astronomy.}$$

But $Z' - Z = x$, and $Z' + Z = 2Z + x$,

therefore,

$$2 \sin. \frac{1}{2} x \sin. (Z + \frac{1}{2} x) = 2 \cos. l \cos. D \sin.^2 \frac{1}{2} P,$$

that is,

$$2 \sin. \frac{1}{2} x \cos. \frac{1}{2} x \sin. Z + 2 \sin.^2 \frac{1}{2} x \cos. Z$$

$$= 2 \cos. l \cos. D \sin.^2 \frac{1}{2} P,$$

$$\text{or } 2 \sin. \frac{1}{2} x \cos. \frac{1}{2} x + 2 \sin.^2 \frac{1}{2} x \cot. Z$$

$$= \frac{2 \cos. l \cos. D}{\sin. Z} \sin.^2 \frac{1}{2} P.$$

In order to resolve this equation, make $\cot. Z = a$, $\frac{\cos. l \cos. D}{\sin. Z} \sin.^2 \frac{1}{2} P = b$, and divide both sides by $2 \cos.^2 \frac{1}{2} x$; it then becomes

$$\tan. \frac{1}{2} x + a \tan.^2 \frac{1}{2} x = \frac{b}{\cos.^2 \frac{1}{2} x} = b (1 + \tan.^2 \frac{1}{2} x).$$

Whence

$$\tan.^2 \frac{1}{2} x + \frac{1}{a - b} \tan. \frac{1}{2} x = \frac{b}{a - b};$$

and, consequently,

$$\tan. \frac{1}{2} x = -\frac{1}{2(a - b)} \pm \frac{1}{2(a - b)} \sqrt{1 + 4b(a - b)}.$$

Developing this expression, and rejecting all the powers of b higher than the cube, we have

$$\tan. \frac{1}{2} x = b - ab^2 + (1 + 2a^2) b^3 - \&c.$$

Now the series which expresses the arc in terms of its tangent (see art. ALGEBRA, p. 270), gives

$$\frac{1}{2} x = \tan. \frac{1}{2} x - \frac{1}{3} \tan.^3 \frac{1}{2} x + \frac{1}{5} \tan.^5 \frac{1}{2} x - \&c.$$

Therefore, by substituting, and rejecting the terms containing higher powers of b than the cube,

$$\frac{1}{2} x = b - ab^2 + (\frac{2}{3} + 2a^2) b^3 - \&c.$$

that is,

$$x = 2b - 2ab^2 + (\frac{4}{3} + 4a^2) b^3 - \&c.$$

and therefore, on restoring the values of a and b , and dividing by $\sin. 1''$,

$$x = 2 \left(\frac{\cos. l \cos. D}{\sin. Z} \right) \cdot \frac{\sin.^2 \frac{1}{2} P}{\sin. 1''} - 2 \cot. Z \left(\frac{\cos. l \cos. D}{\sin. Z} \right)^2 \frac{\sin.^4 \frac{1}{2} P}{\sin. 1''} + 4 \left(\frac{2}{3} + \cot.^2 Z \right) \left(\frac{\cos. l \cos. D}{\sin. Z} \right)^3 \frac{\sin.^6 \frac{1}{2} P}{\sin. 1''} - \&c.$$

The last term of this series is scarcely sensible in any case; it is therefore only necessary to compute the first two.

If, instead of eliminating Z' by means of the equation $Z' - Z = x$, we had eliminated Z , the resulting expression would have been

$$x = -2 \left(\frac{\cos. l \cos. D}{\sin. Z'} \right) \cdot \frac{\sin.^2 \frac{1}{2} P}{\sin. 1''} + 2 \cot. Z' \left(\frac{\cos. l \cos. D}{\sin. Z'} \right)^2 \frac{\sin.^4 \frac{1}{2} P}{\sin. 1''} - \&c.$$

PROBLEM XII.—Given the times of two observed equal altitudes of the sun, to find the true time of his meridional passage.

Let P (fig. 126) be the pole, Z the zenith, ZPM the meridian, and A and C the places of the sun, before and after his meridional passage, when his zenith distances ZA and ZC are observed to be equal. In consequence of the variation of the sun's declination while he passes from A to C, the hour angles APM and MPC are unequal. Make BPM = APM = P, and let BPC be denoted by ϕ . Now, APC = $2P + \phi$; half of which is $P + \frac{1}{2}\phi$; therefore the true time of the meridional passage will be found by subtracting $\frac{1}{2}\phi$ from the mean of the times of observed equal altitudes.

To find the value of ϕ , we have the equation

$$\cos. ZA = \cos. ZP \cos. PA + \sin. ZP \sin. PA \cos. APM;$$

Practical Astronomy. that is (employing the denominations of last problem),
 $\cos. Z = \sin. l \sin. D + \cos. l \cos. D \cos. P \dots (1)$

Now, let $\Delta = Bb$ be the small change of declination corresponding to the variation of the hour-angle from P to $P + \phi$, and let $D + \Delta$ be substituted for D , and $P + \phi$ for P in this equation. It then becomes

$\cos. Z = \sin. l \sin. (D + \Delta) + \cos. l \cos. (D + \Delta) \cos. (P + \phi)$.
 But as Δ and ϕ are very small arcs, their cosines may be made equal to the radius, and their sines equal to the arcs themselves; therefore, on expanding the above equation, it becomes

$\cos. Z = \sin. l \sin. D + \cos. l \cos. D \cos. P$
 $+ (\sin. l \cos. D - \cos. l \sin. D \cos. P) \Delta$
 $- \cos. l \cos. D \sin. P \phi + \cos. l \sin. D \sin. P \Delta \phi$;
 whence, in consequence of equation (1), and rejecting the term multiplied by $\Delta \phi$,
 $(\sin. l \cos. D - \cos. l \sin. D \cos. P) \Delta = \cos. l \cos. D \sin. P \phi$;
 therefore,

$$\phi = \Delta \left(\frac{\tan. l}{\sin. P} - \tan. D \cot. P \right).$$

Let t be the sidereal time of the first observation, t' that of the second, and $t' - t = 2\theta$. Also let the diurnal variation of D be denoted by v , expressed like the arcs ϕ and Δ in seconds; we have then $24^h : 2\theta :: v : \Delta$, whence $\Delta = \frac{1}{12} \theta v$, and consequently

$$\phi = \frac{1}{12} \theta v \left(\frac{\tan. l}{\sin. P} - \tan. D \cot. P \right).$$

Now, to convert ϕ into seconds of time, it is only necessary to divide the number to which it is equal by 15; therefore, expressed in time, ϕ becomes

$$\phi = \frac{1}{180} \theta v \left(\frac{\tan. l}{\sin. P} - \tan. D \cot. P \right).$$

For the angle P we may substitute θ (half the time elapsed between the two observations) converted into degrees, and suppose D to be the value of the declination at the instant of the meridional passage; the value of ϕ being so small as not to be affected by these substitutions. Therefore, ultimately,

$$\frac{1}{2} \phi = \frac{1}{360} \theta v \left(\frac{\tan. l}{\sin. \theta} - \tan. D \cot. \theta \right),$$

which, subtracted from θ , gives the true time of the meridional passage.

PROBLEM XIII.—To compute the angle of the vertical, or the difference between the apparent and geocentric latitude arising from the spheroidal figure of the earth (fig. 127).

Let AMP be a quadrant of the elliptic meridian, C being the centre, and P the pole. The straight line VME , perpendicular to the ecliptic in M , determines the apparent zenith V of the place M , while ZMC drawn through C determines the true zenith Z . Hence the angle ADM is the apparent latitude of M , and ACM its geocentric latitude; and the angle ZMV between the true and apparent zenith is the angle of the vertical.

Let x and y be the rectangular co-ordinates of the point M , the origin being at C , and make $AC = m$, $CP = n$, $ADM = l$, and $ZMV = v$.

The equation of the ellipse gives

$$y^2 = n^2 - \frac{n^2}{m^2} x^2,$$

whence

$$y dy = - \frac{n^2}{m^2} x dx;$$

therefore,

$$\frac{y}{x} = - \frac{n^2}{m^2} \frac{dx}{dy}.$$

Practical Astronomy. But $\frac{y}{x} = \tan. ACM$, and $-\frac{dx}{dy} = \tan. ADM = \tan. l$;

therefore $\tan. ACM = \frac{n^2}{m^2} \tan. l$. Now $ZMV = DMC = ADM - ACM$, therefore $\tan. ZMV = \tan. (ADM - ACM) = \frac{\tan. ADM - \tan. ACM}{1 + \tan. ADM \tan. ACM}$;

that is,

$$\tan. v = \frac{\left(1 - \frac{n^2}{m^2}\right) \tan. l}{1 + \frac{n^2}{m^2} \tan.^2 l} = \frac{(m^2 - n^2) \tan. l}{m^2 + n^2 \tan.^2 l}$$

$$= \frac{(m^2 - n^2) \sin. l \cos. l}{m^2 \cos.^2 l + n^2 \sin.^2 l} = \frac{(m^2 - n^2) \sin. l \cos. l}{m^2 - (m^2 - n^2) \sin.^2 l}$$

Now, let $m - n = 1$, or $n = m - 1$; then, by substituting,

$$\tan. v = \frac{(2m - 1) \sin. l \cos. l}{m^2 - (2m - 1) \sin.^2 l}$$

or, neglecting the terms multiplied by $\frac{1}{m^2}$, and recollecting that $\sin. l \cos. l = \frac{1}{2} \sin. 2l$,

$$\tan. v = \frac{\sin. 2l}{2m} \left(2 - \frac{1}{m} \right) \frac{1}{1 - \frac{2}{m} \sin.^2 l},$$

whence

$$\tan. v = \frac{\sin. 2l}{2m} \left(2 - \frac{1}{m} \right) \left(1 + \frac{2}{m} \sin.^2 l \right);$$

that is,

$$\tan. v = \frac{\sin. 2l}{m} \left(1 - \frac{1}{2m} + \frac{2}{m} \sin.^2 l \right) = \frac{\sin. 2l}{m} \left(1 - \frac{1}{2m} + \frac{1}{m} - \frac{1}{m} \cos.^2 l + \frac{1}{m} \sin.^2 l \right).$$

but $\cos.^2 l - \sin.^2 l = \cos. 2l$; therefore,

$$\tan. v = \frac{\sin. 2l}{m} \left(1 + \frac{1 - 2 \cos. 2l}{2m} \right);$$

and $2 \sin. 2l \cos. 2l = 4 \sin. 4l$; therefore,

$$\tan. v = \frac{\sin. 2l}{m} + \frac{\sin. 2l - \sin. 4l}{2m^2}.$$

The last term of this expression cannot in any case amount to $2''$, so that the angle of the vertical is very nearly proportional to the sine of twice the latitude.

PROBLEM XIV.—To compute the parallax of the moon, or a planet, in altitude.

Let P = the horizontal parallax,
 p = the parallax of altitude,
 Z = the apparent zenith distance.

It was shown in Chap. I. Sect. 2 of THEORETICAL ASTRONOMY that $\sin. p = \sin. P \sin. Z$; now let Z' = the true zenith distance, then $Z = Z' + p$, and consequently

$$\sin. p = \sin. P \sin. (Z' + p) = \sin. P (\sin. Z' \cos. p + \cos. Z' \sin. p),$$

therefore

$$\tan. p = \sin. P (\sin. Z' + \cos. Z' \tan. p) \\ \tan. p (1 - \sin. P \cos. Z') = \sin. P \sin. Z',$$

whence

$$\tan. p = \frac{\sin. P \sin. Z'}{1 - \sin. P \cos. Z'}$$

But by a well-known series,

$$p = \tan. p - \frac{1}{3} \tan.^3 p + \frac{1}{5} \tan.^5 p - \dots \&c.$$

Substituting therefore the above expression for $\tan. p$, and reducing the powers to series, we find

$$p = \frac{\sin. P \sin. Z'}{\sin. 1''} + \frac{\sin.^2 P \sin. 2Z'}{\sin. 2''} + \frac{\sin.^3 P \sin. 3Z'}{\sin. 3''} \&c.$$

Practical Astronomy. The first two terms of this series are in every case sufficient for the computation of p .

PROBLEM XV.—To compute the parallax in right ascension.

In fig. 128 let P be the pole, Z the zenith, A the true place of the moon or a planet, depressed on the vertical circle through the effects of parallax to B . Having joined PA and PB by arcs of great circles, the corresponding variation in right ascension will be represented by the angle APB . Make

P = the horizontal parallax;

p = AB , the parallax of altitude;

Π = APB , the parallax in right ascension;

l = $90^\circ - ZP$, latitude of place;

Δ = PA , the polar distance;

N = ZA , the true zenith distance;

$N+p$ = ZB , the apparent zenith distance;

H = ZPA the hour angle.

In the parallactic triangle APB we have

$$\sin. PA : \sin. AB :: \sin. ABP : \sin. APB;$$

that is,

$$\sin. \Delta : \sin. p :: \sin. ABP : \sin. \Pi,$$

but $\sin. p = \sin. P \sin. (N+p)$. See THEORETICAL ASTRONOMY, Chap. I. Sect. 2.

Therefore,

$$\sin. \Pi = \frac{\sin. P \sin. (N+p) \sin. ABP}{\sin. \Delta}$$

Now, in the triangle ZBP , we have

$$\sin. ZB : \sin. ZP :: \sin. ZPB : \sin. ZBP (ABP);$$

that is,

$$\sin. (N+p) : \cos. l :: \sin. (H+\Pi) : \sin. ABP.$$

Therefore,

$$\sin. ABP = \frac{\cos. l \sin. (H+\Pi)}{\sin. (N+p)},$$

whence

$$\sin. \Pi = \frac{\sin. P \cos. l}{\sin. \Delta} \sin. (H+\Pi).$$

Make $\frac{\sin. P \cos. l}{\sin. \Delta} = A$; then

$$\sin. \Pi = A \sin. (H+\Pi) = A (\sin. H \cos. \Pi + \cos. H \sin. \Pi);$$

whence

$$\tan. \Pi = A (\sin. H + \cos. H \tan. \Pi),$$

and

$$\tan. \Pi (1 - A \cos. H) = A \sin. H;$$

that is,

$$\tan. \Pi = \frac{A \sin. H}{1 - A \cos. H},$$

whence we have the following series,

$$\Pi = A \frac{\sin. H}{\sin. l''} + A^2 \frac{\sin. 2H}{\sin. 2''} + \&c.$$

PROBLEM XVI.—To compute the parallax in declination.

Make $\pi = PB - PA$ (fig. 129) = the parallax in declination.

From the triangle ZPA we get

$$\cos. PZA = \frac{\cos. AP - \cos. PZ \cos. AZ}{\sin. PZ \sin. AZ},$$

and from ZPB

$$\cos. PZB = \frac{\cos. BP - \cos. PZ \cos. BZ}{\sin. PZ \sin. BZ};$$

therefore

$$\frac{\cos. AP - \cos. PZ \cos. AZ}{\sin. AZ} = \frac{\cos. BP - \cos. PZ \cos. BZ}{\sin. BZ},$$

that is (retaining the notation of last problem), $\frac{\cos. \Delta - \sin. l \cos. N}{\sin. N} = \frac{\cos. (\Delta + \pi) - \sin. l \cos. (N+p)}{\sin. (N+p)}$; **Practical Astronomy.**

whence

$$\cos. (\Delta + \pi) = \frac{\cos. \Delta \sin. (N+p)}{\sin. N} - \frac{\sin. l [\cos. N \sin. (N+p) - \sin. N \cos. (N+p)]}{\sin. N}$$

$$= \frac{\cos. \Delta \sin. (N+p)}{\sin. N} - \frac{\sin. l \sin. p}{\sin. N},$$

$$= \frac{\cos. \Delta \sin. (N+p)}{\sin. N} - \frac{\sin. l \sin. P \sin. (N+p)}{\sin. N};$$

therefore

$$\cos. (\Delta + \pi) = \frac{\sin. (N+p)}{\sin. N} [\cos. \Delta - \sin. l \sin. P] \dots (1)$$

Now, from the property of spherical triangles,

$$\sin. ZA : \sin. PA :: \sin. ZPA : \sin. AZP,$$

therefore

$$\sin. AZP = \frac{\sin. PA \sin. ZPA}{\sin. ZA}.$$

For the same reason

$$\sin. BZP = \frac{\sin. PB \sin. ZPB}{\sin. ZB};$$

therefore

$$\frac{\sin. PA \sin. ZPA}{\sin. ZA} = \frac{\sin. PB \sin. ZPB}{\sin. ZB},$$

that is,

$$\frac{\sin. \Delta \sin. H}{\sin. N} = \frac{\sin. (\Delta + \pi) \sin. (H + \Pi)}{\sin. (N+p)},$$

whence

$$\frac{\sin. (N+p)}{\sin. N} = \frac{\sin. (\Delta + \pi) \sin. (H + \Pi)}{\sin. \Delta \sin. H}.$$

By substituting this in equation (1) there results

$$\cos. (\Delta + \pi) = \frac{\sin. (\Delta + \pi) \sin. (H + \Pi)}{\sin. \Delta \sin. H} [\cos. \Delta - \sin. l \sin. P],$$

whence

$$\cot. (\Delta + \pi) = \frac{\sin. (H + \Pi)}{\sin. H} \left\{ \cot. \Delta - \frac{\sin. l \sin. P}{\sin. \Delta} \right\}.$$

Make $\frac{\sin. l \sin. P}{\sin. \Delta} = \cot. \alpha$, then

$$\cot. (\Delta + \pi) = \frac{\sin. (H + \Pi)}{\sin. H} (\cot. \Delta - \cot. \alpha),$$

that is,

$$\cot. (\Delta + \pi) = \frac{\sin. (H + \Pi) \sin. (\alpha - \Delta)}{\sin. H \sin. \alpha \sin. \Delta},$$

from which, as Δ is known, $\cot. (\Delta + \pi)$ may be computed, and thence π . A more convenient formula, however, may be obtained by proceeding as follows. (See Delambre, *Abrégé d'Astronomie*, p. 154).

From the equation

$$\cot. (\Delta + \pi) = \frac{\sin. (H + \Pi)}{\sin. H} \left(\cot. \Delta - \frac{\sin. l \sin. P}{\sin. \Delta} \right)$$

we have

$$\cot. \Delta = \frac{\sin. H \cot. (\Delta + \pi)}{\sin. (H + \Pi)} + \frac{\sin. l \sin. P}{\sin. \Delta};$$

whence

$$\cot. \Delta - \cot. (\Delta + \pi) = \frac{\sin. H \cot. (\Delta + \pi)}{\sin. (H + \Pi)} - \cot. (\Delta + \pi) + \frac{\sin. l \sin. P}{\sin. \Delta};$$

but $\cot. \Delta - \cot. (\Delta + \pi) =$

Practical Astronomy. $\frac{\sin.(\Delta + \pi) \cos. \Delta - \cos.(\Delta + \pi) \sin. \Delta}{\sin.(\Delta + \pi) \sin. \Delta} = \frac{\sin. \pi}{\sin.(\Delta + \pi) \sin. \Delta}$; therefore

$$\frac{\sin. \pi}{\sin.(\Delta + \pi) \sin. \Delta} = \frac{\sin. l \sin. P}{\sin. \Delta} - \cot.(\Delta + \pi) [\sin. (H + \Pi) - \sin. H]$$

Now, by the trigonometrical formulæ, the difference of the sines of two arcs is equal to twice the sine of half their difference multiplied by the cosine of half their sum, therefore

$$\sin. (H + \Pi) - \sin. H = 2 \sin. \frac{1}{2} \Pi \cos. (H + \frac{1}{2} \Pi),$$

whence

$$\frac{\sin. \pi}{\sin.(\Delta + \pi) \sin. \Delta} = \frac{\sin. l \sin. P}{\sin. \Delta} - \frac{2 \sin. \frac{1}{2} \Pi \cos. (H + \frac{1}{2} \Pi) \cot.(\Delta + \pi)}{\sin. (H + \Pi)}$$

$$\text{and } \sin. \pi = \sin. l \sin. P \sin. (\Delta + \pi) - \frac{2 \sin. \frac{1}{2} \Pi \sin. \Delta \cos. (H + \frac{1}{2} \Pi) \cos. (\Delta + \pi)}{\sin. (H + \Pi)}$$

$$\text{or, since } 2 \sin. \frac{1}{2} \Pi = \frac{\sin. \Pi}{\cos. \frac{1}{2} \Pi},$$

$$\sin. \pi = \sin. l \sin. P \sin. (\Delta + \pi) - \frac{\sin. \Pi \sin. \Delta \cos. (H + \frac{1}{2} \Pi) \cos. (\Delta + \pi)}{\cos. \frac{1}{2} \Pi \sin. (H + \Pi)}$$

But it was shown in the last problem that

$$\sin. \Pi = \frac{\sin. P \cos. l}{\sin. \Delta} \sin. (H + \Pi),$$

whence

$$\frac{\sin. \Pi \sin. \Delta}{\sin. (H + \Pi)} = \sin. P \cos. l;$$

consequently,

$$\sin. \pi = \sin. l \sin. P \sin. (\Delta + \pi) - \frac{\sin. P \cos. l \cos. (H + \frac{1}{2} \Pi) \cos. (\Delta + \pi)}{\cos. \frac{1}{2} \Pi}$$

$$\text{Make } \tan. x = \frac{\cos. (H + \frac{1}{2} \Pi) \cot. l}{\cos. \frac{1}{2} \Pi}; \text{ then, by substituting,}$$

$$\sin. \pi = \sin. l \sin. P [\sin. (\Delta + \pi) - \tan. x \cos. (\Delta + \pi)],$$

$$\text{or } \sin. \pi = \frac{\sin. l \sin. P}{\cos. x} [\sin. (\Delta + \pi) \cos. x - \cos. (\Delta + \pi) \sin. x],$$

$$\sin. \pi = \frac{\sin. l \sin. P}{\cos. x} \sin. (\Delta + \pi - x),$$

$$\frac{\sin. \pi}{\cos. x} = \frac{\sin. l \sin. P}{\cos. x} [\sin. (\Delta - x) \cos. \pi + \cos. (\Delta - x) \sin. \pi];$$

whence,

$$\tan. \pi = \frac{\sin. l \sin. P}{\cos. x} [\sin. (\Delta - x) + \cos. (\Delta - x) \tan. \pi];$$

$$\text{therefore (making } \frac{\sin. l \sin. P}{\cos. x} = B),$$

$$\tan. \pi = \frac{B \sin. (\Delta - x)}{1 - B \cos. (\Delta - x)}, \text{ consequently}$$

$$\pi = B \frac{\sin. (\Delta - x)}{\sin. 1''} + B^2 \frac{\sin. 2 (\Delta - x)}{\sin. 2''} + B^3 \frac{\sin. 3 (\Delta - x)}{\sin. 3''} + \&c.$$

PROBLEM XVII.—To compute the altitude and longitude of the nonagesimal.

The nonagesimal is the point of the ecliptic where that circle intersects the vertical plane passing through its

pole. It is consequently the highest point of the ecliptic above the horizon, or 90° from the horizon measured on the ecliptic.

Let HH' (fig. 129) be the horizon, EO the ecliptic, EQ the equator, Z the zenith, P the pole of the equator, and P' the pole of the ecliptic. The great circle passing through P' and P intersects EO and EQ at right angles in C and D, whence $EC = ED = 90^\circ = MQ$, and therefore $EM = DQ$. In like manner $PD = 90^\circ = P'C$, consequently $PP' = CD$ the obliquity of the ecliptic.

The great circle PZNI which passes through the pole of the ecliptic and the zenith is a circle of latitude and also a vertical circle; hence the angles at N and I are right angles, and O is the pole of PZNI; consequently $OI = ON = 90^\circ$. Now since $ON = 90^\circ$, the point N is the nonagesimal, and its altitude $IN = 90^\circ - ZN = ZP'$ = the complement of the altitude of the pole of the ecliptic, or the co-latitude of the zenith. In like manner its longitude $EN = 90^\circ - NC = 90^\circ - ZP'P$. Now in order to compute ZP' and the angle $ZP'P$, we have given, in the triangle ZPP', the side ZP = the co-latitude, PP' = the obliquity, and also the angle ZPP', for $ZPP' = 180^\circ - ZPD = 180^\circ - MD = 180^\circ - (ED - EM) = 180^\circ - 90^\circ + EM = 90^\circ + EM$, and EM (which is the right ascension of the zenith, or as it is technically called, the right ascension of the mid-heaven) is given, being equal to the sidereal time of observation converted into degrees.

Let $R = EM$ the right ascension of the zenith, $\lambda = PZ$ the co-latitude of the place (reduced by problem XIII.), $\omega = PP'$ the obliquity of the ecliptic, $K = P'Z$ the co-latitude of the zenith or altitude of the nonagesimal, $N = 90^\circ - ZP'P$ the longitude of the nonagesimal.

By the trigonometrical formulæ,

$$\cos. K = \cos. \lambda \cos. \omega + \sin. \lambda \sin. \omega \cos. (90^\circ + R)$$

$$= \cos. \lambda \cos. \omega + \sin. \lambda \sin. \omega \sin. R.$$

Assume $\tan. \phi = \tan. \lambda \sin. R$, then, by substituting and reducing, we obtain

$$\cos. K = \frac{\cos. \lambda}{\cos. \phi} \cos. (\omega + \phi).$$

To find the longitude L, we have

$$\tan. N = \frac{\cot. \lambda \sin. \omega}{\sin. (90^\circ + R)} - \cot. (90^\circ + R) \cos. \omega$$

$$= \frac{\cot. \lambda \sin. \omega}{\cos. R} + \tan. R \cos. \omega,$$

$$\text{But } \tan. \lambda = \frac{\tan. \phi}{\sin. R}, \text{ whence } \cot. \lambda = \frac{\sin. R}{\tan. \phi},$$

whence, by substituting,

$$\tan. N = \tan. R \left(\frac{\sin. \omega}{\tan. \phi} + \cos. \omega \right),$$

and on reducing,

$$\tan. N = \frac{\tan. R}{\sin. \phi} \sin. (\omega + \phi),$$

PROBLEM XVIII.—To compute the parallax in longitude and latitude.

Let A (fig. 129) be the place of the star situated on the vertical ZAR; Ea is its longitude, and P'A the complement of its latitude, or its distance from the pole of the ecliptic. Suppose that, through the effects of parallax, it is depressed from A to B; its longitude then becomes Eb, and its distance from the pole of the ecliptic P'B, so that ab is the variation in longitude, and P'B - PA the variation in latitude, which it is required to compute. Now it is evident that these quantities will be given in terms of the different parts of the triangle APB, exactly in the same manner as the parallax in right ascension and declination has been found from the triangle APB

Practical Astronomy. (fig. 128). The angle ZPA, which was before denoted by H, now becomes ZP'A = Na = Ea — EN = longitude of the star — longitude of the nonagesimal, and ZPB becomes ZP'B = Nb = Na + ab. Retaining, therefore, the notation employed in the three last problems, and making L = Ea the longitude of the star, Δ' = PA its distance from the pole of the ecliptic, k = ZP' = 90° — K, Π' = ab its parallax in longitude, π' = P'B — P'A its parallax in latitude, we shall have Π' and π' from the same formulæ as Π and π in Problems XV. and XVI., by changing l into k, H into L — N, and Δ into Δ'. Hence (Problem XV.)

$$\sin. \Pi' = \frac{\sin. P \cos. k}{\sin. \Delta'}, \sin. (L - N + \Pi'),$$

and by putting $C = \frac{\sin. P \cos. k}{\sin. \Delta'}$, we deduce

$$\tan. \Pi' = \frac{C \sin. (L - N)}{1 - C \cos. (L - N)} \text{ and}$$

$$\Pi' = \sin. C \frac{\sin. (L - N)}{\sin. 1''} + C^2 \frac{\sin. 2 (L - N)}{\sin. 2''} +, \&c.$$

In like manner the formula for the parallax in declination given in Problem XVI., viz.

$$\cot. (\Delta + \pi) = \frac{\sin. (H + \Pi)}{\sin. H} \left[\cot. \Delta - \frac{\sin. l \sin. P}{\sin. \Delta} \right]$$

becomes

$$\cot. (\Delta' + \pi') = \frac{\sin. (L - N + \Pi')}{\sin. (L - N)} \left[\cot. \Delta' - \frac{\sin. k \sin. P}{\sin. \Delta'} \right];$$

from which, by proceeding in the same manner as in Problem XVI., and making

$$\tan. x' = \frac{\cos. (L - N + \frac{1}{2} \Pi') \cot. k}{\cos. \frac{1}{2} \Pi'}$$

$$\text{we deduce } \tan. \pi' = \frac{\sin. k \sin. P}{\cos. x'} \left[\sin. (\Delta' - x') + \cos. (\Delta' - x') \tan. \pi' \right]$$

$$\text{whence, on making } \frac{\sin. k \sin. P}{\cos. x'} = D,$$

$$\tan. \pi' = \frac{D \sin. (\Delta - x')}{1 - D \cos. (\Delta' - x')},$$

consequently

$$\pi' = D \frac{\sin. (\Delta' - x')}{\sin. 1''} + D^2 \frac{\sin. 2 (\Delta' - x')}{\sin. 2''} +, \&c.$$

PROBLEM XIX.—Given the apparent altitudes of the moon and the sun, or a star, and the apparent distance between them, to find the true distance.

This is a problem of great importance in Practical Astronomy, because the observed distance between the moon and the sun or a star is the surest means the navigator has to determine his longitude.

To obtain the apparent distance and altitudes, it is convenient to have three observers: one, the most expert, takes the apparent distance of the limb of the moon from that of the sun, or from the star; another observes the moon's altitude at the moment of the observation of the distance; and a third takes the star's altitude. For greater accuracy, these simultaneous operations ought to be repeated several times, and a fourth assistant may, by a good watch, note the intervals of time between them. A mean of the whole will then be obtained, and the corresponding time by the watch, by which the true time at that place will be nearly known. If there be only one observer, he must take the altitudes immediately before and after the distance, and endeavour to allow for the change of altitude during the time between the observations.

The observed distance between the limbs of the moon and sun must be increased by their semidiameters to ob-

tain the distance of their centres. If the distance from a star is taken, because its diameter is insensible, the distance is to be increased by the moon's semidiameter only.

The observed altitudes thus found are affected by parallax and refraction. The moon's horizontal parallax is given in the *Nautical Almanac*: from this the parallax at the time of observation may be found by Prob. XIV., but the navigator avails himself of aid from *The Requisite Tables*, which shorten the process of calculation. The sun's parallax is almost insensible, but it may be taken into account; that of a star is accounted nothing. The altitudes are diminished by the parallaxes, but they are increased by refraction. The sun's altitude is more increased by the latter than diminished by the former; but the reverse happens with the moon. At sea the altitudes must be also corrected for the *dip of the horizon* (that is, for the height of the observer above the surface of the sea), and the refraction for the height of the thermometer.

Supposing all this done, let S and M be the true places of the sun or star and moon (fig. 130), Z the zenith; because parallax and refraction take place only in vertical circles, the apparent place of the sun, s, will be in the vertical ZS above S, and that of the moon, m, in ZM below M. The apparent distance will be sm.

Let A = 90° — ZM be the moon's true altitude; a = 90° — ZS the star's true altitude; H = 90° — Zm the moon's apparent altitude; h = 90° — Zs the star's apparent altitude; D = SM the true, and d = sm the apparent distance.

By spherical trigonometry, in the triangles SZM, sZm,

$$\cos. SZM \begin{cases} = \frac{\cos. D - \sin. A \sin. a}{\cos. A \cos. a}, \\ = \frac{\cos. d - \sin. H \sin. h}{\cos. H \cos. h} \end{cases}$$

From these equal values of cos. SZM we find

$$\begin{aligned} \cos D &= (\cos. d - \sin. H \sin. h) \frac{\cos. A \cos. a}{\cos. H \cos. h} + \sin. A \sin. a \\ &= [\cos. d + \cos. (H + h) - \cos. H \cos. h] \frac{\cos. A \cos. a}{\cos. H \cos. h} \\ &\quad + \sin. A \sin. a \\ &= 2 \cos. \frac{1}{2} (H + h + d) \cos. \frac{1}{2} (H + h - d) \frac{\cos. A \cos. a}{\cos. H \cos. h} \\ &\quad - (\cos. A \cos. a - \sin. A \sin. a). \end{aligned}$$

But the last term = cos. (A + a); subtract now both sides from 1; then, observing that by the calculus of sines (see ALGEBRA)

$$1 - \cos. D = 2 \sin.^2 \frac{1}{2} D,$$

$$1 + \cos. (A + a) = 2 \cos.^2 \frac{1}{2} (A + a),$$

we have, after dividing by 2, and putting

$$F = \frac{\cos. A \cos. a}{\cos. H \cos. h},$$

$$\begin{aligned} \sin.^2 \frac{1}{2} D &= \cos.^2 \frac{1}{2} (A + a) \\ &\quad - \cos. \frac{1}{2} (H + h + d) \cos. \frac{1}{2} (H + h - d) \times F \\ &= \cos.^2 \frac{1}{2} (A + a) \left[1 - \frac{\cos. \frac{1}{2} (H + h + d) \cos. \frac{1}{2} (H + h - d)}{\cos.^2 \frac{1}{2} (A + a)} \times F \right]. \end{aligned}$$

Let θ be such an angle that

$$\sin.^2 \theta = \frac{\cos. \frac{1}{2} (H + h + d) \cos. \frac{1}{2} (H + h - d) \cos. A \cos. a}{\cos.^2 \frac{1}{2} (A + a) \cos. H \cos. h};$$

and in this expression the value of F is put instead of it, then we have

$$\sin.^2 \frac{1}{2} D = \cos.^2 \frac{1}{2} (A + a) \cos.^2 \theta;$$

$$\text{and } \sin. \frac{1}{2} D = \cos. \frac{1}{2} (A + a) \cos. \theta.$$

The value of cos. D in the first formula may serve to determine D, but not conveniently; by the various steps of the analytic process it is transformed into another, viz.

Practical the last, which gives $\sin. \frac{1}{2} D$, and consequently D readily by logarithmic calculation.

The final result is the rule found by Borda: as a practical rule it is very convenient, because no attention is necessary to the signs of the trigonometrical quantities. On this account it is well adapted to seamen.

PROBLEM XX.—To find the longitude of a ship at sea by an observation of the distance of the moon from the sun or a star.

From the observed distance, the true distance as it would appear if it could be seen from the earth's centre, may be found by the last problem: Now by the *Nautical Almanac* this is given for every third hour, Greenwich time, therefore, by an easy calculation, the time at which the observation was made, as it would be given by a watch showing Greenwich time, may be obtained. But the time of observation as reckoned at the ship may be found from the ship's latitude, the moon's or star's zenith distances (found by the observation), and their polar distances as given by the Almanac. Therefore the difference between the time of the observation as estimated at the ship and the corresponding Greenwich time becomes known: This difference is the ship's longitude.

Example. At sea, June 5, 1793, about an hour and a half after noon, in $10^{\circ} 46' 50''$ south latitude, and 149° longitude, by account, by means of a set of lunar observations made at a height of about 20 feet above the surface of the sea, it was found that

Distance of nearest limbs of $\odot$ and J ... $83^{\circ} 26' 46''$

Altitude of lowest limb of $\odot$ $48^{\circ} 16' 10''$

Altitude of upper limb of J $27^{\circ} 53' 30''$

Hence the longitude of the ship is required.

Reduction of the apparent to the true altitude.

Dist. of nearest limbs of $\odot$ and J $83^{\circ} 26' 46''$

Semidiam. of $\odot$ } from Naut. Almanac..... { $0^{\circ} 15' 46''$
of J } { $0^{\circ} 14' 54''$

Augmentation of the latter, prop. to altitude... $0^{\circ} 0' 7''$

Apparent distance (d) of centres..... $83^{\circ} 57' 33''$

Altitude of sun's lower limb..... $48^{\circ} 16' 10''$

Subtract for dip of horizon..... $0^{\circ} 4' 24''$

..... $48^{\circ} 11' 46''$

Semidiameter..... $0^{\circ} 15' 46''$

Apparent altitude of sun's centre (h)..... $48^{\circ} 27' 32''$

Refr. — par. — correct. for therm..... $0^{\circ} 0' 43''$

True altitude of sun's centre (a)..... $48^{\circ} 26' 49''$

Altitude of moon's upper limb..... $27^{\circ} 53' 30''$

Correct for dip..... $0^{\circ} 4' 24''$

..... $27^{\circ} 49' 6''$

Semidiameter $0^{\circ} 15' 1''$

Apparent altitude of moon's centre (H)..... $27^{\circ} 34' 5''$

Par. — refr. + corr. for therm..... $0^{\circ} 46' 43''$

True alt. of moon's centre (A)..... $28^{\circ} 20' 48''$

Reduction of the apparent to the true distance by Prob. XIX.

d $83^{\circ} 57' 33''$

h $48^{\circ} 27' 32''$ ar. com. cos. $\cdot 1783835$

H $27^{\circ} 34' 5''$ ar. com. cos. $\cdot 0523390$

sum $159^{\circ} 59' 10''$

$\frac{1}{2}$ sum $79^{\circ} 59' 35''$cos. $9\cdot 2399686$

$d - \frac{1}{2}$ sum $3^{\circ} 57' 58''$cos. $9\cdot 9989587$

a $48^{\circ} 26' 49''$cos. $9\cdot 8217187$

A $28^{\circ} 20' 48''$cos. $9\cdot 9445275$

$A + a = 76^{\circ} 47' 37''$ $39\cdot 2358960$

$\frac{1}{2}(A + a) = 38^{\circ} 23' 48''$2 log. cos. $19\cdot 7883324$

2) $19\cdot 4475636$

$\theta = 31^{\circ} 57' 33''$cos. $0^{\circ} 9\cdot 7237818$

sin. $9\cdot 9285875$

$\frac{1}{2}(A + a) = 38^{\circ} 23' 48''$cos. $9\cdot 8941662$

$\frac{1}{2} D = 41^{\circ} 40' 27''$sin. $9\cdot 8227537$

$D = 83^{\circ} 20' 55''$ nearly.

Computation of time at Greenwich.

By Nautical Almanac for 1793

Dist. J from $\odot$ { at 15 hours..... $83^{\circ} 6' 1''$
at 18..... $84^{\circ} 28' 26''$

Increase of dist. in 3 hours = $1^{\circ} 22' 25''$

D = $83^{\circ} 20' 55''$

Dist. J from $\odot$ at 15 hours..... $83^{\circ} 6' 1''$

$0^{\circ} 14' 54''$

Hence it appears that in 3 hours the distance of the moon from the sun was increased by $1^{\circ} 22' 25'' = 4595''$, and that between the time of making the observation, and the 15th hour, Greenwich time, the increase of distance was $0^{\circ} 14' 54'' = 894''$. Now for small intervals the distances will increase nearly as the times, therefore we have

$4945'' : 894'' :: 3\text{h.} : 0\text{h.} \cdot 5425 = 32\text{m. } 33\text{s.}$

Thus it appears that the observation must have been made 32 minutes 33 seconds after the 15th hour, Greenwich time.

We have yet to find the correct time of the observation as estimated at the ship. To determine this, we know the sun's altitude $48^{\circ} 26' 49''$, and the sun's declination, which is given in the Almanac for Greenwich, noon; and from this the declination at the time of the observation is found by making allowance for the difference of longitude and the hour from noon at the ship, both known nearly. The declination thus found is $23^{\circ} 22' 48''$ north. The ship's latitude, $10^{\circ} 16' 40''$, is also known. Hence to find the hour angle by Problem IV. we have

λ the colat. = $79^{\circ} 43' 20''$,

Δ the pol. dist. = $113^{\circ} 22' 48''$,

z the zenith dist. = $41^{\circ} 33' 11''$.

To find P the hour angle, the computation (see formula of Prob. IV.) may stand thus:—

sin. $\frac{1}{2}(z + \lambda - \Delta)$ $3^{\circ} 56' 51''$ $8\cdot 8378559$

sin. $\frac{1}{2}(z - \lambda + \Delta)$ $37^{\circ} 36' 19''$ $9\cdot 7854851$

sin. $\frac{1}{2}(\lambda + \Delta + z)$ $117^{\circ} 19' 39''$ ar. comp. $0\cdot 0513929$

sin. $\frac{1}{2}(\lambda + \Delta - z)$ $75^{\circ} 46' 28''$ ar. comp. $0\cdot 0135256$

2) $18\cdot 6882595$

tan. ($\frac{1}{2} P = 12^{\circ} 27' 17''$) $9\cdot 3441297$

$P = 24^{\circ} 54' 35'' =$ $1^{\text{h}} 39^{\text{m}} 38^{\text{s}} \cdot 3$

time at Greenwich = $15^{\text{h}} 32^{\text{m}} 33^{\text{s}} \cdot 0$

Long. from Greenwich westward $13^{\text{h}} 52^{\text{m}} 54^{\text{s}} \cdot 7$

Therefore, longitude east of Greenwich is $10^{\text{h}} 7^{\text{m}} 4^{\text{s}} \cdot 3$

We have put down the result to seconds, as it comes out by the calculation; but such accuracy is not attainable in nautical practice. Delambre says, "even with the best instruments, the most skilful navigators find anomalies for which they cannot account. The lunar tables are in a state of continual improvement, yet we cannot be sure that there is not an error of $20''$ in a distance, which will produce an error of $40''$ of time. To this possible error of theory must be joined that of the observation, which may be still greater. The error of the time may therefore amount to $80''$, which is equivalent to $20'$, or $\frac{1}{3}$ of a degree. This should be the maximum of the error; and, in general, this degree of accuracy is sufficient. Indeed a greater accuracy than $\frac{1}{3}$ of a degree may sometimes be obtained, but still it is uncertain.

Practical Astronomy.

Practical Astronomy.

CHAP. II.

CALCULATION OF NEW AND FULL MOON, AND ECLIPSES.

SECT. I.—Tables for Computing New and Full Moon, and the Elements for Eclipses.

TABLE I.

The Mean Time of New Moon in January, New Style, with the Mean Anomalies of the Sun and Moon, and the Moon's Mean Distance from the Ascending Node from 1801 to 1900 inclusive.

Years.	Mean New Moon in January.	Secular Equation.	Moon's Mean Anomaly.	Secular Equation.	Sun's Mean Anomaly.	Moon's Mean Distance from Ascending Node.	Secular Equation.	Years.	Mean New Moon in January.	Secular Equation.	Moon's Mean Anomaly.	Secular Equation.	Sun's Mean Anomaly.	Moon's Mean Distance from Ascending Node.	Secular Equation.
	D. H. M. S.	s.	S. D. M. S.	s.	S. D. M. S.	S. D. M. S.	s.		D. H. M. S.	s.	S. D. M. S.	s.	S. D. M. S.	S. D. M. S.	s.
1801	14 7 39 9	0	0 26 7 39	0	0 14 16 42	9 10 35 50	0	1851	2 5 20 40	-6	4 20 58 29	+10	0 1 23 10	5 4 58 48	-2
1802	3 16 27 43	0	11 5 55 49	0	0 3 32 33	9 18 38 37	0	1852B.	21 2 53 17	6	3 26 35 40	10	0 19 45 20	6 13 41 49	2
1803	22 14 0 21	0	10 11 33 0	0	0 21 54 43	10 27 21 37	0	1853	9 11 41 52	6	2 6 23 50	11	0 9 1 12	6 21 44 35	2
1804B.	11 22 48 55	0	8 21 21 11	0	0 11 10 35	11 5 24 24	0	1854	28 9 14 29	6	1 12 1 2	11	0 27 23 22	8 0 27 36	2
1805	29 20 21 32	0	7 26 58 22	0	0 29 32 45	0 14 7 24	0	1855	17 18 3 3	6	11 21 49 12	12	0 16 39 13	8 8 30 22	2
1806	19 5 10 7	0	6 6 46 32	0	0 18 48 36	0 22 10 11	0	1856B.	7 2 51 38	7	10 1 37 22	12	0 5 55 5	8 16 33 9	2
1807	8 13 58 41	0	4 16 34 42	0	0 8 4 27	1 0 12 57	0	1857	25 0 24 15	7	9 7 14 33	12	0 24 17 15	9 25 16 10	2
1808B.	27 11 31 18	0	3 22 11 53	0	0 26 26 38	2 8 55 58	0	1858	14 9 12 49	7	7 17 2 43	13	0 13 33 6	10 3 18 56	3
1809	15 20 19 52	0	2 2 0 4	0	0 15 42 29	2 16 58 44	0	1859	3 18 1 23	7	5 26 50 54	13	0 2 48 58	10 11 21 43	3
1810	5 5 8 27	0	0 11 48 14	0	0 4 58 20	2 25 1 31	0	1860B.	22 15 34 1	8	5 2 28 5	14	0 21 11 8	11 20 4 43	3
1811	24 2 41 4	0	11 17 25 25	0	0 23 20 31	4 3 44 31	0	1861	11 0 22 35	8	3 12 16 15	14	0 10 26 59	11 28 7 30	3
1812B.	13 11 29 38	0	9 27 13 35	+1	0 12 36 22	4 11 47 18	0	1862	29 21 55 12	8	2 17 53 26	15	0 28 49 10	1 6 50 31	3
1813	1 20 18 13	0	8 7 1 46	1	0 1 52 13	4 19 50 4	0	1863	19 6 43 47	8	0 27 41 36	15	0 18 5 1	1 14 53 17	3
1814	20 17 50 50	0	7 12 38 57	1	0 20 14 24	5 28 33 5	0	1864B.	8 15 32 21	9	11 7 29 47	16	0 7 20 52	1 22 56 4	3
1815	10 2 39 25	0	5 22 27 7	1	0 9 30 15	6 6 35 51	0	1865	26 13 4 58	9	10 13 6 58	16	0 25 43 3	3 1 39 4	3
1816B.	29 0 12 2	-1	4 28 4 18	1	0 27 52 26	7 15 18 52	0	1866	15 21 53 33	9	8 22 55 8	17	0 14 58 54	3 9 41 51	3
1817	17 9 0 36	1	3 7 52 29	1	0 17 8 17	7 23 21 39	0	1867	5 6 42 7	10	7 2 43 18	17	0 4 14 45	3 17 44 37	3
1818	6 17 49 11	1	1 17 40 39	1	0 6 24 8	8 1 24 25	0	1868B.	24 4 14 44	10	6 8 20 29	18	0 22 36 56	4 26 27 38	4
1819	25 15 21 48	1	0 23 17 50	1	0 24 46 19	9 10 7 26	0	1869	12 13 3 18	10	4 18 8 40	18	0 11 52 47	5 4 30 24	4
1820B.	15 0 10 23	1	11 3 6 1	2	0 14 2 10	9 18 10 12	0	1870	1 21 51 53	10	2 27 56 50	19	0 1 8 38	5 12 33 11	4
1821	3 8 58 57	1	9 12 54 11	2	0 3 18 1	9 26 12 59	0	1871	20 19 24 30	11	2 3 34 1	19	0 19 30 49	6 21 16 11	4
1822	22 6 31 34	1	8 18 31 22	2	0 21 40 12	11 4 55 59	0	1872B.	10 4 13 4	11	0 13 22 11	20	0 8 46 40	6 29 18 58	4
1823	11 15 20 8	1	6 28 19 32	2	0 10 56 3	11 12 58 46	0	1873	28 1 45 42	11	11 18 59 22	20	0 27 8 50	8 8 1 58	4
1824B.	1 0 8 43	1	5 8 7 42	2	0 0 11 54	11 21 1 32	0	1874	17 10 34 16	12	9 28 47 33	21	0 16 24 42	8 16 4 45	4
1825	18 21 41 20	1	4 13 44 53	2	0 18 34 4	0 29 44 33	0	1875	6 19 22 50	12	8 8 35 43	22	0 5 40 33	8 24 7 31	4
1826	8 6 29 54	1	2 23 33 4	3	0 7 49 56	1 7 47 19	-1	1876B.	25 16 55 27	12	7 14 12 54	22	0 24 2 43	10 2 50 32	4
1827	27 4 2 31	2	1 29 10 15	3	0 26 12 6	2 16 30 19	1	1877	14 1 44 2	13	5 24 1 5	23	0 13 18 35	10 10 53 18	5
1828B.	16 12 51 5	2	0 8 58 25	3	0 15 27 57	2 24 33 6	1	1878	3 10 32 36	13	4 3 49 15	23	0 2 34 26	10 18 56 5	5
1829	4 21 39 40	2	10 18 46 35	3	0 4 43 49	3 2 35 52	1	1879	22 8 5 13	13	3 9 26 26	24	0 20 56 36	11 27 39 5	5
1830	23 19 12 17	2	9 24 23 46	3	0 23 5 59	4 11 18 53	1	1880B.	11 16 53 48	14	1 19 14 37	25	0 10 12 27	0 5 41 52	5
1831	13 4 0 51	2	8 4 11 56	4	0 12 21 49	4 19 21 39	1	1881	29 14 26 25	14	0 24 51 48	25	0 28 34 38	1 14 24 52	5
1832B.	2 12 49 25	2	6 14 0 6	4	0 1 37 42	4 27 24 26	1	1882	18 23 14 59	14	11 4 39 58	26	0 17 50 29	1 22 27 39	5
1833	20 10 22 3	2	5 19 37 18	4	0 19 59 52	6 6 7 26	1	1883	8 8 3 34	15	9 14 28 8	26	0 7 6 20	2 0 30 25	5
1834	9 19 10 37	2	3 29 25 28	4	0 9 15 43	6 14 10 13	1	1884B.	27 5 36 11	15	8 20 5 20	27	0 25 28 31	3 9 13 26	5
1835	28 16 43 15	3	3 5 2 39	5	0 27 37 54	7 22 53 13	1	1885	15 14 24 46	16	6 29 53 30	28	0 14 44 22	3 17 16 12	5
1836B.	18 1 31 49	3	1 14 50 49	5	0 16 53 45	8 0 56 0	1	1886	4 23 13 20	16	5 9 41 40	28	0 4 0 13	3 25 18 59	6
1837	6 10 20 23	3	11 24 39 0	5	0 6 9 36	8 8 58 47	1	1887	23 20 45 57	16	4 15 18 51	29	0 22 22 24	5 4 2 0	6
1838	25 7 53 1	3	11 0 16 11	6	0 24 31 47	9 17 41 47	1	1888B.	13 5 34 32	17	2 25 7 1	30	0 11 38 15	5 12 4 46	6
1839	14 16 41 35	3	9 10 4 21	6	0 13 47 38	9 25 44 34	1	1889	1 14 23 6	17	1 4 55 12	30	0 0 54 6	5 20 7 33	6
1840B.	4 1 30 10	3	7 19 52 32	6	0 3 3 29	10 3 47 20	1	1890	20 11 55 44	18	0 10 32 23	31	0 19 16 17	6 28 50 33	6
1841	21 23 2 47	4	6 25 29 43	6	0 21 25 40	11 12 30 21	1	1891	9 20 44 18	18	10 20 20 33	32	0 8 32 8	7 6 53 20	6
1842	11 7 51 21	4	5 5 17 53	7	0 10 41 31	11 20 33 8	1	1892B.	28 18 16 55	18	9 25 57 44	33	0 26 54 19	8 15 36 21	6
1843	30 5 23 59	4	4 10 55 5	7	0 29 3 41	0 29 16 8	1	1893	17 3 5 30	19	8 5 45 54	33	0 16 10 10	8 23 39 7	7
1844B.	19 14 12 33	4	2 20 43 15	7	0 18 19 33	1 7 18 55	1	1894	6 11 54 4	19	6 15 34 5	34	0 5 26 1	9 1 41 54	7
1845	7 23 1 8	4	1 0 31 25	8	0 7 35 24	1 15 21 41	2	1895	25 9 26 42	20	5 21 11 16	35	0 23 48 12	10 10 24 54	7
1846	26 20 33 45	5	0 6 8 36	8	0 25 57 34	2 24 4 42	2	1896B.	14 18 15 16	20	4 0 59 26	35	0 13 4 3	10 18 27 41	7
1847	16 5 22 19	5	10 15 56 47	8	0 15 13 26	3 2 7 28	2	1897	3 3 3 50	20	2 10 47 36	36	0 2 19 54	10 26 30 27	7
1848B.	5 14 10 54	5	8 25 44 57	9	0 4 29 17	3 10 10 15	2	1898	22 0 36 28	21	1 16 24 47	37	0 20 42 4	0 5 13 28	7
1849	23 11 43 31	5	8 1 22 8	9	0 22 51 27	4 18 53 15	2	1899	11 9 25 2	21	11 26 12 58	38	0 9 57 56	0 13 16 14	7
1850	12 20 32 6	5	6 11 10 19	10	0 12 7 19	4 26 56 2	2	1900C.	30 6 57 39	21	11 1 50 9	38	0 28 20 6	1 21 59 15	8

TABLE II.

Quantities to be added to the Epochs in Table I. for the Nineteenth Century, in order to obtain the Epochs of the corresponding Years in other Centuries. The sign — indicates the past Centuries, and + the future, in respect to the Nineteenth Century.

Years.	Mean New Moon.				Moon's Mean Anomaly.				Sun's Mean Anomaly.				Moon's Mean Distance from Ascending Node.			
Old Style.	D.	H.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.
— 2600	22	20	36	13	10	25	47	43	1	29	10	40	4	8	0	22
— 2500	27	4	43	18	7	11	18	23	2	2	29	56	8	27	26	33
— 2400	2	0	6	19	3	1	0	2	1	6	42	53	0	16	12	30
— 2300	6	8	13	24	11	16	30	42	1	10	2	9	5	5	38	42
— 2200	10	16	20	29	8	2	1	22	1	13	21	25	9	25	4	53
— 2100	15	0	27	33	4	17	32	2	1	16	40	41	2	14	31	4
— 2000	19	8	34	38	1	3	2	42	1	19	59	57	7	3	57	15
— 1900	23	16	41	42	9	18	33	22	1	23	19	13	11	23	23	26
— 1800	28	0	48	47	6	4	4	2	1	26	38	29	4	12	49	37
— 1700	2	20	11	49	1	23	45	42	1	0	51	26	8	1	35	34
— 1600	7	4	18	54	10	9	16	22	1	4	10	42	0	21	1	45
— 1500	11	12	25	59	6	24	47	2	1	7	29	58	5	10	27	57
— 1400	15	20	33	4	3	10	17	42	1	11	49	14	9	29	54	8
— 1300	20	4	40	8	11	25	48	22	1	14	8	30	2	19	20	19
— 1200	24	12	47	13	8	11	19	3	1	17	27	46	7	8	46	30
— 1100	28	20	54	18	4	26	49	43	1	20	47	2	11	28	12	41
— 1000	3	16	17	20	0	16	31	22	0	24	59	59	3	16	58	38
— 900	8	0	24	25	9	2	2	2	0	28	19	16	8	6	24	49
— 800	12	8	31	29	5	17	32	42	1	1	38	31	0	25	51	0
— 700	16	16	38	34	2	3	3	22	1	4	57	47	5	15	17	11
— 600	21	0	45	39	10	18	34	2	1	8	17	3	10	4	43	22
— 500	25	8	52	43	7	4	4	42	1	11	36	18	2	24	9	33
— 400	0	4	15	45	2	23	46	21	0	15	49	15	6	12	55	30
— 300	4	12	22	50	11	9	17	1	0	19	8	31	11	2	21	41
— 200	8	20	29	54	7	24	47	41	0	22	27	47	3	21	47	52
— 100	13	4	36	58	4	10	18	21	0	25	47	3	8	11	14	3
New Style.																
— 300	14	12	22	50	11	9	17	1	0	19	8	31	11	2	21	41
— 200	18	20	29	54	7	24	47	41	0	22	27	47	3	21	47	52
— 100	24	4	36	58	4	10	18	21	0	25	47	3	8	11	14	3
+ 100	5	8	7	5	8	15	30	40	0	3	19	16	4	19	26	11
+ 200	9	16	14	9	5	1	1	20	0	6	38	32	9	8	52	22

TABLE III.
Secular Equations.

Years.	Time of Mean New Moon.			Moon's Mean Anomaly.			Sun's Mean Anomaly.			Moon's Mean Distance from Ascending Node.			Years.	Time of Mean New Moon.			Moon's Mean Anomaly.			Sun's Mean Anomaly.			Moon's Mean Distance from Ascending Node.		
B. C.	H.	M.	S.	D.	M.	S.	M.	S.		D.	M.	S.	A. C.	H.	M.	S.	D.	M.	S.	M.	S.		D.	M.	S.
800	3	52	5	+	6	56	7	—	18	44	—	1	22	19	701	0	42	30	+	1	16	11	—	3	23
700	3	34	54		6	25	19		17	20		1	16	13	801	0	35	10		1	3	4		2	48
600	3	18	21		5	55	39		15	59		1	10	21	901	0	28	32		0	51	9		2	16
500	3	2	27		5	27	7		14	41		1	4	42	1001	0	22	35		0	40	29		1	48
400	2	47	11		4	59	45		13	17		0	59	18	1101	0	17	19		0	31	2		1	23
300	2	32	33		4	33	32		12	16		0	54	6											
200	2	18	35		4	8	29		11	8		0	49	9	1201	0	12	44		0	22	50		1	1
100	2	5	16		3	44	36		10	3		0	44	26	1301	0	8	51		0	15	53		0	42
A. C.															1401	0	5	41		0	10	11		0	27
1	1	52	36		3	21	53		9	2		0	39	56	1501	0	3	12		0	5	44		0	15
101	1	40	35		3	0	21		8	4		0	35	40	1601	0	1	25		0	2	32		0	7
201	1	29	14		2	39	59		7	9		0	31	39											
301	1	18	33		2	20	50		6	17		0	27	51	1701	0	0	21		0	0	38		0	2
401	1	8	31		2	2	52		5	29		0	24	18	1801	0	0	0		0	0	0		0	0
501	0	59	10		1	46	6		4	44		0	20	59	1901	0	0	21		0	0	38		0	2
601	0	50	30		1	30	32		4	2		0	17	54	2001	0	1	26		0	2	34		0	7

TABLE IV.

Mean Anomalies of the Sun and Moon, and Moon's Mean Distance from Ascending Node for Mean Lunations.

No.	Mean Lunations.	Moon's Mean Anomaly.				Sun's Mean Anomaly.				Moon's Mean Distance from Ascending Node.			
		D.	H.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.
1	January	29	12	44	3	0	25	49	1	0	29	6	19
2	February	28	1	28	6	1	21	38	2	1	28	12	39
3	March	29	14	12	9	2	17	27	3	2	27	18	58
4	April	28	2	56	11	3	13	16	3	3	26	25	17
5	May	27	15	40	14	4	9	5	4	4	25	31	37
6	June	26	4	24	17	5	4	54	5	5	24	37	56
7	July	25	17	8	20	6	0	43	6	6	23	44	16
8	August	24	5	52	23	6	26	32	7	7	22	50	35
9	September	22	18	36	26	7	22	21	8	8	21	56	54
10	October	22	7	20	29	8	18	10	9	9	21	3	14
11	November	20	20	4	31	9	13	59	9	10	20	9	33
12	December	20	8	48	34	10	9	48	10	11	19	15	52
$\frac{1}{2}$		14	18	22	1	6	12	54	30	0	14	33	10
										6	15	20	7

TABLE V.

First Equation for the Times of New and Full Moon.

Argument. Moon's Mean Anomaly.																			
	O.s.			I.s.			II.s.			III.s.			IV.s.			V.s.			
	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	
0°	0	0	0	4	34	26	8	10	3	9	48	59	8	50	0	5	14	24	30°
1	0	9	28	4	42	54	8	15	32	9	49	42	8	45	11	5	5	2	29
2	0	18	56	4	51	18	8	20	52	9	50	14	8	40	10	4	55	34	28
3	0	28	24	4	59	38	8	26	5	9	50	35	8	34	59	4	45	59	27
4	0	37	52	5	7	54	8	31	9	9	50	45	8	29	36	4	36	18	26
5	0	47	19	5	16	4	8	36	6	9	50	44	8	24	5	4	26	31	25
6	0	56	45	5	24	10	8	40	53	9	50	33	8	18	23	4	16	38	24
7	1	6	10	5	32	12	8	45	32	9	50	10	8	12	30	4	6	40	23
8	1	15	35	5	40	9	8	50	2	9	49	36	8	6	27	3	36	3	22
9	1	24	59	5	48	1	8	54	24	9	48	51	8	0	14	3	46	27	21
10	1	34	21	5	55	48	8	58	36	9	47	55	7	53	50	3	36	13	20
11	1	43	42	6	3	29	9	2	40	9	46	48	7	47	17	3	25	54	19
12	1	53	2	6	11	5	9	6	34	9	45	29	7	40	35	3	15	31	18
13	2	2	20	6	18	36	9	10	20	9	43	59	7	33	42	3	5	3	17
14	2	11	37	6	26	1	9	13	55	9	42	18	7	26	40	2	54	31	16
15	2	20	51	6	33	20	9	17	22	9	40	26	7	19	28	2	43	56	15
16	2	30	4	6	40	33	9	20	38	9	38	22	7	12	7	2	33	16	14
17	2	39	15	6	47	40	9	23	46	9	36	8	7	4	37	2	22	34	13
18	2	48	23	6	54	41	9	26	43	9	33	42	6	56	58	2	11	48	12
19	2	57	29	7	1	36	9	29	30	9	31	4	6	49	11	2	0	59	11
20	3	6	33	7	8	24	9	32	8	9	28	16	6	41	14	1	50	8	10
21	3	15	34	7	15	6	9	34	36	9	25	16	6	33	9	1	39	14	9
22	3	24	33	7	21	41	9	36	53	9	22	5	6	24	55	1	28	18	8
23	3	33	28	7	28	9	9	39	0	9	18	44	6	16	33	1	17	20	7
24	3	42	21	7	34	30	9	40	57	9	15	10	6	8	3	1	6	20	6
25	3	51	10	7	40	44	9	42	44	9	11	26	5	59	26	0	55	19	5
26	3	59	56	7	46	52	9	44	20	9	7	31	5	50	39	0	44	17	4
27	4	8	39	7	52	50	9	45	46	9	3	25	5	41	47	0	33	13	3
28	4	17	18	7	58	42	9	47	1	8	59	8	5	32	46	0	22	9	2
29	4	25	54	8	4	26	9	48	5	8	54	39	5	23	38	0	11	5	1
30	4	34	26	8	10	3	9	48	59	8	50	0	5	14	24	0	0	0	0
	+ XI.s.			+ X.s.			+ IX.s.			+ VIII.s.			+ VII.s.			+ VI.s.			

Second Equation for the Times of New and Full Moon for the year 1801, with the Secular Variation.

Argument. Sun's Mean Anomaly.																								
	O. ^s +			I. ^s +			Secular Variation.	II. ^s +			Secular Variation.	III. ^s +			Secular Variation.	IV. ^s +			Secular Variation.	V. ^s +			Secular Variation.	
	H.	M.	S.	H.	M.	S.	S.	H.	M.	S.	S.	H.	M.	S.	S.	H.	M.	S.	S.	H.	M.	S.	S.	
0°	0	0	0	2	8	39	20	3	40	48	33	4	11	50	38	3	35	30	32	2	3	21	18	30°
1	0	4	30	2	12	30	20	3	42	54	34	4	11	41	38	3	33	13	32	1	59	35	18	29
2	0	9	1	2	16	17	21	3	44	56	34	4	11	28	38	3	30	52	31	1	55	47	17	28
3	0	13	31	2	20	3	21	3	46	54	34	4	11	10	38	3	28	28	31	1	51	56	16	27
4	0	18	1	2	23	45	22	3	48	48	35	4	10	48	38	3	26	0	31	1	48	4	16	26
5	0	22	30	2	27	25	22	3	50	37	35	4	10	20	38	3	23	29	30	1	44	10	15	25
6	0	26	59	2	31	1	23	3	52	22	35	4	9	49	37	3	20	53	30	1	40	14	15	24
7	0	31	28	2	34	35	24	3	54	3	35	4	9	13	37	3	18	15	29	1	36	17	14	23
8	0	35	55	2	38	6	24	3	55	39	36	4	8	32	37	3	15	33	29	1	32	17	14	22
9	0	40	23	2	41	34	25	3	57	11	36	4	7	47	37	3	12	47	29	1	28	16	13	21
10	0	44	49	2	44	59	25	3	58	38	36	4	6	58	37	3	9	58	28	1	24	14	12	20
11	0	49	15	2	48	20	26	4	0	1	36	4	6	4	37	3	7	6	28	1	20	10	12	19
12	0	53	39	2	51	38	26	4	1	20	36	4	5	6	37	3	4	11	27	1	16	5	11	18
13	0	58	3	2	54	53	27	4	2	33	37	4	4	3	37	3	1	12	27	1	11	59	11	17
14	1	2	25	2	58	5	27	4	3	43	37	4	2	56	36	2	58	11	26	1	7	51	10	16
15	1	6	46	3	1	13	28	4	4	48	37	4	1	44	36	2	55	6	26	1	3	42	9	15
16	1	11	6	3	4	18	28	4	5	48	37	3	0	28	36	2	51	58	25	0	59	32	9	14
17	1	15	24	3	7	19	28	4	6	44	37	3	59	8	36	2	48	47	25	0	55	22	8	13
18	1	19	41	3	10	16	29	4	7	35	37	3	57	44	36	2	45	33	25	0	51	10	8	12
19	1	23	56	3	13	10	29	4	8	21	37	3	56	15	35	2	42	16	24	0	46	57	7	11
20	1	28	10	3	16	0	30	4	9	3	37	3	54	42	35	2	38	57	24	0	42	43	6	10
21	1	32	22	3	18	46	30	4	9	41	38	3	53	5	35	2	35	35	23	0	38	29	6	9
22	1	36	32	3	21	29	31	4	10	14	38	3	51	24	35	2	32	10	23	0	34	14	5	8
23	1	40	41	3	24	8	31	4	10	42	38	3	49	38	34	2	28	42	22	0	29	59	4	7
24	1	44	47	3	26	43	31	4	11	5	38	3	47	49	34	2	25	12	21	0	25	43	4	6
25	1	48	51	3	29	14	32	4	11	24	38	3	45	56	34	2	21	40	21	0	21	27	3	5
26	1	52	53	3	31	40	32	4	11	39	38	3	43	58	33	2	18	5	20	0	17	9	3	4
27	1	56	53	3	34	3	32	4	11	48	38	3	41	57	33	2	16	27	20	0	12	52	2	3
28	2	0	51	3	36	22	33	4	11	53	38	3	39	52	33	2	10	47	19	0	8	35	1	2
29	2	4	46	3	38	37	33	4	11	54	38	3	37	43	32	2	7	5	19	0	4	18	1	1
30	2	8	39	3	40	48	33	4	11	50	38	3	35	30	32	2	3	21	18	0	0	0	0	0
	XI. ^s			X. ^s			+	IX. ^s			+	VIII. ^s			+	VII. ^s			+	VI. ^s			+	

Multiply the Secular Variations by the number of years between the given time and the year 1801, and divide the product by 100. If the given time be before 1801, change the sign of the Secular Variation.

TABLE VII.

Third Equation for the Times of New and Full Moon.

Argument. Moon's Mean Anomaly <i>plus</i> Sun's Mean Anomaly.							
	O.s. — VI.s. +		I.s. — VII.s. +		II.s. — VIII.s. +		
	M.	S.	M.	S.	M.	S.	
0°	0	0	3	33	6	9	30°
1	0	7	3	39	6	13	29
2	0	15	3	46	6	16	28
3	0	22	3	52	6	20	27
4	0	30	3	58	6	23	26
5	0	37	4	4	6	26	25
6	0	44	4	10	6	29	24
7	0	52	4	16	6	32	23
8	0	59	4	22	6	35	22
9	1	7	4	28	6	38	21
10	1	14	4	34	6	40	20
11	1	21	4	39	6	43	19
12	1	29	4	45	6	45	18
13	1	36	4	50	6	47	17
14	1	43	4	56	6	49	16
15	1	50	5	1	6	51	15
16	1	57	5	6	6	53	14
17	2	5	5	12	6	55	13
18	2	12	5	17	6	57	12
19	2	19	5	21	6	58	11
20	2	26	5	26	6	59	10
21	2	33	5	31	7	1	9
22	2	40	5	36	7	2	8
23	2	46	5	40	7	3	7
24	2	53	5	45	7	4	6
25	3	0	5	49	7	4	5
26	3	7	5	53	7	5	4
27	3	13	5	57	7	5	3
28	3	20	6	1	7	6	2
29	3	26	6	5	7	6	1
30	3	33	6	9	7	6	0
	+ XI.s. — V.s.		+ X.s. — IV.s.		+ IX.s. — III.s.		

TABLE VIII.

Fourth Equation for the Times of New and Full Moon.

Argument. Moon's Mean Anomaly <i>minus</i> Sun's Mean Anomaly.							
	O. ^s + VII. ^s —		I. ^s + VII. ^s —		II. ^s + VIII. ^s —		
	M.	S.	M.	S.	M.	S.	
0°	0	0	5	17	9	10	30°
1	0	11	5	27	9	15	29
2	0	22	5	37	9	20	28
3	0	33	5	46	9	25	27
4	0	44	5	55	9	30	26
5	0	55	6	4	9	36	25
6	1	6	6	13	9	41	24
7	1	18	6	22	9	45	23
8	1	29	6	31	9	49	22
9	1	40	6	39	9	53	21
10	1	50	6	48	9	57	20
11	2	1	6	56	10	1	19
12	2	12	7	5	10	4	18
13	2	23	7	13	10	7	17
14	2	33	7	21	10	11	16
15	2	44	7	29	10	14	15
16	2	55	7	37	10	16	14
17	3	5	7	45	10	19	13
18	3	16	7	52	10	21	12
19	3	27	7	59	10	23	11
20	3	37	8	7	10	25	10
21	3	48	8	14	10	27	9
22	3	58	8	20	10	29	8
23	4	8	8	27	10	30	7
24	4	18	8	34	10	32	6
25	4	28	8	40	10	33	5
26	4	38	8	46	10	33	4
27	4	48	8	52	10	34	3
28	4	58	8	58	10	35	2
29	5	7	9	4	10	35	1
30	5	17	9	10	10	35	0
	— XI. ^s + V. ^s		— X. ^s + IV. ^s		— IX. ^s + III. ^s		

TABLE IX.

Fifth Equation for the Times of New and Full Moon.

Argument. Twice Moon's Mean Distance from As- cending Node <i>minus</i> Moon's Mean Anomaly.							
	O.s. + VI.s. —		I.s. + VII.s. —		II.s. + VIII.s. —		
	M.	S.	M.	S.	M.	S.	
0°	0	0	1	18	2	16	30°
1	0	3	1	21	2	17	29
2	0	5	1	23	2	19	28
3	0	8	1	25	2	20	27
4	0	11	1	28	2	21	26
5	0	14	1	30	2	22	25
6	0	16	1	32	2	23	24
7	0	19	1	34	2	24	23
8	0	22	1	37	2	26	22
9	0	25	1	39	2	27	21
10	0	27	1	41	2	28	20
11	0	30	1	43	2	28	19
12	0	33	1	45	2	29	18
13	0	35	1	47	2	30	17
14	0	38	1	49	2	31	16
15	0	41	1	51	2	32	15
16	0	43	1	53	2	32	14
17	0	46	1	55	2	33	13
18	0	48	1	57	2	34	12
19	0	51	1	58	2	34	11
20	0	54	2	0	2	35	10
21	0	56	2	2	2	35	9
22	0	59	2	4	2	35	8
23	1	1	2	5	2	36	7
24	1	4	2	7	2	36	6
25	1	6	2	9	2	36	5
26	1	9	2	10	2	37	4
27	1	11	2	12	2	37	3
28	1	14	2	13	2	37	2
29	1	16	2	15	2	37	1
30	1	18	2	16	2	37	0
	— XI.s. + V.s.		— X.s. + IV.s.		— IX.s. + III.s.		

TABLE X.

Sixth Equation for the Times of New and Full Moon.

Argument. Moon's Mean Distance from Ascending Node.							
	O.s. + VI.s. +		I.s. + VII.s. +		II.s. + VIII.s. +		
0°	M.	s.	M.	s.	M.	s.	30°
	0	0	1	40	1	40	
1	0	4	1	42	1	38	29
2	0	8	1	44	1	36	28
3	0	12	1	46	1	34	27
4	0	16	1	48	1	31	26
5	0	20	1	49	1	29	25
6	0	24	1	50	1	26	24
7	0	28	1	51	1	23	23
8	0	32	1	53	1	21	22
9	0	36	1	53	1	18	21
10	0	40	1	54	1	15	20
11	0	43	1	55	1	11	19
12	0	47	1	55	1	8	18
13	0	51	1	56	1	5	17
14	0	54	1	56	1	1	16
15	0	58	1	56	0	58	15
16	1	1	1	56	0	54	14
17	1	5	1	56	0	51	13
18	1	8	1	55	0	47	12
19	1	11	1	55	0	43	11
20	1	15	1	54	0	40	10
21	1	18	1	53	0	36	9
22	1	21	1	53	0	32	8
23	1	23	1	51	0	28	7
24	1	26	1	50	0	24	6
25	1	29	1	49	0	20	5
26	1	31	1	48	0	16	4
27	1	34	1	46	0	12	3
28	1	36	1	44	0	8	2
29	1	38	1	42	0	4	1
30	1	40	1	40	0	0	0
	— XI.s. — V.s.		— X.s. — IV.s.		— IX.s. — III.s.		

TABLE XI.

Seventh Equation for the Times of New and Full Moon.

Argument. Twice the Moon's Mean Anomaly plus the Sun's Mean Anomaly.				
	O.s. — VI.s. +	I.s. — VII.s. +	II.s. — VIII.s. +	
0°	s. 0	s. 18	s. 31	30°
5	3	21	33	25
10	6	23	34	20
15	9	25	35	15
20	12	28	35	10
25	15	29	36	5
30	18	31	36	0
	+ XI.s. — V.s.	+ X.s. — IV.s.	+ IX.s. — III.s.	

TABLE XII.

Eighth Equation for the Times of New and Full Moon.

Argument. Twice the Moon's Mean Anomaly minus the Sun's Mean Anomaly.				
	O.s. — VI.s. +	I.s. — VII.s. +	II.s. — VIII.s. +	
0°	s. 0	s. 5	s. 9	30°
5	1	6	9	25
10	2	6	9	20
15	3	7	10	15
20	3	8	10	10
25	4	8	10	5
30	5	9	10	0
	+ XI.s. — V.s.	+ X.s. — IV.s.	+ IX.s. — III.s.	

TABLE XIII.

Ninth Equation for the Time of Full Moon *only*.

Argument. Moon's Mean Anomaly.					
	O.s. + VI.s. —	I.s. + VII.s. —	II.s. + VIII.s. —		
0°	M. s. 0 0	M. s. 0 43	M. s. 1 15		30°
1	0 1	0 45	1 16		29
2	0 3	0 46	1 17		28
3	0 5	0 47	1 17		27
4	0 6	0 49	1 18		26
5	0 8	0 50	1 19		25
6	0 9	0 51	1 19		24
7	0 11	0 52	1 20		23
8	0 12	0 54	1 21		22
9	0 14	0 55	1 21		21
10	0 15	0 56	1 22		20
11	0 17	0 57	1 22		19
12	0 18	0 58	1 23		18
13	0 20	0 59	1 23		17
14	0 21	1 0	1 24		16
15	0 22	1 1	1 24		15
16	0 24	1 3	1 24		14
17	0 25	1 4	1 25		13
18	0 27	1 5	1 25		12
19	0 28	1 6	1 25		11
20	0 30	1 7	1 26		10
21	0 31	1 8	1 26		9
22	0 33	1 9	1 26		8
23	0 34	1 9	1 26		7
24	0 35	1 10	1 26		6
25	0 37	1 11	1 27		5
26	0 38	1 12	1 27		4
27	0 39	1 13	1 27		3
28	0 41	1 14	1 27		2
29	0 42	1 15	1 27		1
30	0 43	1 15	1 27		0
	+ XI.s. — V.s.	+ X.s. — IV.s.	+ IX.s. — III.s.		

TABLE XIV.

Tenth Equation for the Time of Full Moon *only*.

Argument. Sun's Mean Anomaly.				
	O.s. + VI.s. —	I.s. + VII.s. —	II.s. + VIII.s. —	
0°	s. 0	s. 16	s. 29	30°
5	3	19	30	25
10	6	21	31	20
15	9	23	32	15
20	11	25	32	10
25	14	27	33	5
30	16	29	33	0
	+ XI.s. — V.s.	+ X.s. — IV.s.	+ IX.s. — III.s.	

TABLE XV.

Sun's Mean Motion from the Moon's Perigee and Ascending Node, and Variation of the Sun's Mean Anomaly, for Hours, Minutes, and Seconds.

For Hours.															
	Sun's Mean Motion from Moon's Perigee.		Sun's Mean Anomaly.		Sun's Mean Motion from Ascending Node.			Sun's Mean Motion from Moon's Perigee.		Sun's Mean Anomaly.		Sun's Mean Motion from Ascending Node.			
H.	M.	S.	M.	S.	D.	M.	S.	H.	M.	S.	M.	S.	D.	M.	S.
1	2	11	2	28	0	2	36	13	28	25	32	2	0	33	45
2	4	22	4	56	0	5	12	14	30	36	34	30	0	36	21
3	6	33	7	23	0	7	47	15	32	47	36	58	0	38	57
4	8	44	9	51	0	10	23	16	34	58	39	26	0	41	33
5	10	55	12	19	0	12	59	17	37	9	41	53	0	44	8
6	13	7	14	47	0	15	35	18	39	20	44	21	0	46	44
7	15	18	17	15	0	18	10	19	41	31	46	49	0	49	20
8	17	29	19	43	0	20	46	20	43	43	49	17	0	51	56
9	19	40	22	11	0	23	22	21	45	54	51	45	0	54	32
10	21	51	24	38	0	25	58	22	48	5	54	13	0	57	7
11	24	2	27	6	0	28	34	23	50	16	56	40	0	59	43
12	26	13	29	34	0	31	9	24	52	27	59	8	1	2	19

For Minutes and Seconds.													
	Sun's Mean Motion from Moon's Perigee.		Sun's Mean Anomaly.		Sun's Mean Distance from Ascending Node.			Sun's Mean Motion from Moon's Perigee.		Sun's Mean Anomaly.		Sun's Mean Distance from Ascending Node.	
M.	M.	S.	M.	S.	M.	S.	M.	M.	S.	M.	S.	M.	S.
S.	S.	T.	S.	T.	S.	T.	S.	S.	T.	S.	T.	S.	T.
1	0	2	0	2	0	3	31	1	8	1	16	1	20
2	0	4	0	5	0	5	32	1	10	1	19	1	23
3	0	7	0	7	0	8	33	1	12	1	21	1	26
4	0	9	0	10	0	10	34	1	15	1	24	1	28
5	0	11	0	12	0	13	35	1	17	1	26	1	31
6	0	13	0	15	0	16	36	1	19	1	29	1	33
7	0	15	0	17	0	18	37	1	21	1	31	1	36
8	0	17	0	20	0	21	38	1	23	1	34	1	39
9	0	20	0	22	0	23	39	1	25	1	36	1	41
10	0	22	0	25	0	26	40	1	27	1	39	1	44
11	0	24	0	27	0	29	41	1	30	1	41	1	46
12	0	26	0	30	0	31	42	1	32	1	43	1	49
13	0	28	0	32	0	34	43	1	34	1	46	1	52
14	0	31	0	34	0	36	44	1	36	1	48	1	54
15	0	33	0	37	0	39	45	1	38	1	51	1	57
16	0	35	0	39	0	41	46	1	41	1	53	1	59
17	0	37	0	42	0	44	47	1	43	1	56	2	2
18	0	39	0	44	0	47	48	1	45	1	58	2	5
19	0	42	0	47	0	49	49	1	47	2	1	2	7
20	0	44	0	49	0	52	50	1	49	2	3	2	10
21	0	46	0	52	0	54	51	1	51	2	6	2	12
22	0	48	0	54	0	57	52	1	54	2	8	2	15
23	0	50	0	57	1	0	53	1	56	2	11	2	18
24	0	52	0	59	1	2	54	1	58	2	13	2	20
25	0	55	1	2	1	5	55	2	0	2	15	2	23
26	0	57	1	4	1	7	56	2	2	2	18	2	25
27	0	59	1	6	1	10	57	2	4	2	20	2	28
28	1	1	1	9	1	13	58	2	6	2	23	2	31
29	1	3	1	11	1	15	59	2	8	2	25	2	33
30	1	6	1	14	1	18	60	2	11	2	28	2	36

TABLE XVI.

Equation of the Sun's Centre for 1801, with the Secular Variation.

Argument. Sun's Mean Anomaly.																											
	O.s.			Secular Variation.	I.s.			Secular Variation.	II.s.			Secular Variation.	III.s.			Secular Variation.	IV.s.			Secular Variation.	V.s.			Secular Variation.			
	+	—			+	—			+	—			+	—			+	—			+	—				+	—
0°	D.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.	S.	30°		
	0	0	0	0	0	58	48	9	1	41	3	15	1	55	27	17	1	38	57	15	0	56	42	8			
1	0	2	4	0	1	0	34	9	1	42	1	15	1	55	23	17	1	37	54	14	0	54	58	8	29		
2	0	4	7	1	1	2	18	9	1	42	57	15	1	55	18	17	1	36	50	14	0	53	13	8	28		
3	0	6	10	1	1	4	1	10	1	43	52	16	1	55	10	17	1	35	44	14	0	51	27	8	27		
4	0	8	14	1	1	5	43	10	1	44	44	16	1	55	0	17	1	34	36	14	0	49	41	7	26		
5	0	10	17	2	1	7	23	10	1	45	34	16	1	54	48	17	1	33	27	14	0	47	53	7	25		
6	0	12	20	2	1	9	3	10	1	46	23	16	1	54	34	17	1	32	16	14	0	46	5	7	24		
7	0	14	22	2	1	10	41	11	1	47	9	16	1	54	18	17	1	31	3	13	0	44	16	6	23		
8	0	16	25	2	1	12	17	11	1	47	54	16	1	54	0	17	1	29	49	13	0	42	26	6	22		
9	0	18	27	3	1	13	52	11	1	48	36	16	1	53	39	17	1	28	33	13	0	40	35	6	21		
10	0	20	28	3	1	15	26	11	1	49	17	16	1	53	17	17	1	27	16	13	0	38	44	6	20		
11	0	22	30	3	1	16	58	12	1	49	55	16	1	52	53	17	1	25	57	13	0	36	52	5	19		
12	0	24	31	4	1	18	29	12	1	50	31	17	1	52	26	17	1	24	37	12	0	34	59	5	18		
13	0	26	31	4	1	19	58	12	1	51	5	17	1	51	58	17	1	23	15	12	0	33	6	5	17		
14	0	28	31	4	1	21	26	12	1	51	37	17	1	51	27	16	1	21	52	12	0	31	12	5	16		
15	0	30	30	5	1	22	53	13	1	52	8	17	1	50	55	16	1	20	27	12	0	29	17	4	15		
16	0	32	29	5	1	24	17	13	1	52	36	17	1	50	20	16	1	19	1	12	0	27	23	4	14		
17	0	34	27	5	1	25	40	13	1	53	2	17	1	49	44	16	1	17	33	11	0	25	27	4	13		
18	0	36	25	6	1	27	2	13	1	53	25	17	1	49	6	16	1	16	4	11	0	23	31	3	12		
19	0	38	21	6	1	28	21	13	1	53	47	17	1	48	25	16	1	14	34	11	0	21	35	3	11		
20	0	40	17	6	1	29	39	14	1	54	7	17	1	47	43	16	1	13	2	11	0	19	39	3	10		
21	0	42	13	6	1	30	56	14	1	54	24	17	1	46	59	16	1	11	29	10	0	17	42	3	9		
22	0	44	7	7	1	32	10	14	1	54	40	17	1	46	13	16	1	9	56	10	0	15	45	2	8		
23	0	46	0	7	1	33	23	14	1	54	53	17	1	45	25	16	1	8	20	10	0	13	47	2	7		
24	0	47	53	7	1	34	34	14	1	55	4	17	1	44	35	15	1	6	44	10	0	11	49	2	6		
25	0	49	45	8	1	35	44	14	1	55	13	17	1	43	43	15	1	5	6	10	0	9	51	1	5		
26	0	51	35	8	1	36	51	15	1	55	20	17	1	42	49	15	1	3	28	9	0	7	53	1	4		
27	0	53	25	8	1	37	57	15	1	55	25	17	1	41	54	15	1	1	48	9	0	5	55	1	3		
28	0	55	14	8	1	39	1	15	1	55	28	17	1	40	57	15	1	0	7	9	0	3	57	1	2		
29	0	57	2	9	1	40	3	15	1	55	28	17	1	39	58	15	0	58	25	9	0	1	58	0	1		
30	0	58	48	9	1	41	3	15	1	55	27	17	1	38	57	15	0	56	42	8	0	0	0	0	0		
	—			+	—			+	—			+	—			+	—			+	—			+			
	XI.s.				X.s.				IX.s.				VIII.s.				VII.s.				VI.s.						

Multiply the secular variations by the number of years between the given time and the year 1801, and divide the product by 100.
If the time is before 1801, change the sign of the secular variation.

TABLE XVII.

For the Moon's Latitude and Inclination of her relative Orbit to the Ecliptic in Eclipses.

Argument. Moon's True distance from Ascending Node.					
LATITUDE.			INCLINATION.		
O.s. + increasing. VI.s.			O.s. left. VI.s.		
— increasing.			right.		
D.	M.	S.	D.	M.	S.
0°	0	0	30°	5	44
1	0	5	29	5	44
2	0	10	28	5	44
3	0	15	27	5	43
4	0	21	26	5	43
5	0	26	25	5	43
6	0	31	24	5	42
7	0	36	23	5	41
8	0	42	22	5	41
9	0	47	21	5	40
10	0	52	20	5	39
11	0	57	19	5	38
12	1	2	18	5	37
13	1	8	17	5	35
14	1	13	16	5	34
15	1	18	15	5	32
16	1	23	14	5	31
17	1	28	13	5	29
18	1	33	12	5	27
19	1	38	11	5	25
20	1	43	10	5	23
+ decreasing. V.s.			right. V.s.		
— decreasing. XI.s.			left. XI.s.		

In Lunar Eclipses change the designation "right" or "left" of the Inclination.

TABLE XVIII.

For the Moon's Latitude in Eclipses.

Argument. Moon's True Anomaly minus True Distance from Ascending Node.				
	O.s. — VI.s. +	I.s. — VII.s. +	II.s. — VIII.s. +	
0°	s. 0	s. 6	s. 11	30°
5	1	7	11	25
10	2	8	12	20
15	3	9	12	15
20	4	10	12	10
25	5	10	13	5
30	6	11	13	0
	+ XI.s. — V.s.	+ X.s. — IV.s.	+ IX.s. — III.s.	

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TABLE XIX.

For the Moon's Latitude in Eclipses.

Argument. Preceding argument, plus Moon's True Anomaly.				
	O.s. + VI.s. —	I.s. + VII.s. —	II.s. + VIII.s. —	
0°	s. 0	s. 13	s. 22	30°
5	2	15	23	25
10	4	17	24	20
15	7	18	25	15
20	9	20	25	10
25	11	21	26	5
30	13	22	26	0
	— XI.s. + V.s.	— X.s. + IV.s.	— IX.s. + III.s.	

TABLE XX.

For the Moon's Latitude in Eclipses.

Argument. Moon's True Anomaly plus True Distance from Ascending Node.				
	O.s. + VI.s. —	I.s. + VII.s. —	II.s. + VIII.s. —	
0°	s. 0	s. 8	s. 15	30°
5	1	10	15	25
10	3	11	16	20
15	4	12	16	15
20	6	13	17	10
25	7	14	17	5
30	8	15	17	0
	— XI.s. + V.s.	— X.s. + IV.s.	— IX.s. + III.s.	

TABLE XXI.

For the Moon's Latitude in Eclipses.

Argument. Sun's True Anomaly plus Moon's True Distance from Ascending Node.				
	O.s. + VI.s. —	I.s. + VII.s. —	II.s. + VIII.s. —	
0°	s. 0	s. 10	s. 17	30°
5	2	11	18	25
10	3	13	18	20
15	5	14	19	15
20	7	15	19	10
25	8	16	20	5
30	10	17	20	0
	— XI.s. + V.s.	— X.s. + IV.s.	— IX.s. + III.s.	

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TABLE XXII.

For the Moon's Latitude in Eclipses.

Argument. Sun's True Anomaly minus Moon's True Distance from Ascending Node.				
	O.s. + VI.s. —	I.s. + VII.s. —	II.s. + VIII.s. —	
0°	s. 0	s. 16	s. 28	30°
5	3	19	30	25
10	6	21	31	20
15	8	23	31	15
20	11	25	32	10
25	14	27	32	5
30	16	28	33	0
	XI.s. + V.s.	X.s. + IV.s.	IX.s. + III.s.	

TABLE XXIV.

Diminution of the Moon's Equatorial Horizontal Parallax, and of the Latitude of a Place, on account of the Spheroidal Figure of the Earth.

Arguments. Latitude at the Side, and Moon's Horizontal Parallax at the Top.				
	Diminution of Parallax.			Diminution of Latitude.
	M. 53	M. 57	M. 61	
0°	s. 0	s. 0	s. 0	M. 0-0
5	0	0	0	2-0
10	0	0	0	4-0
15	1	1	1	5-8
20	1	1	1	7-5
25	2	2	2	8-9
30	3	3	3	10-1
35	3	4	4	11-0
40	4	5	5	11-5
45	5	6	6	11-7
50	6	7	7	11-5
55	7	8	8	11-0
60	8	9	9	10-1
65	9	10	10	9-0
70	10	10	11	7-5
75	10	11	12	5-9
80	10	11	12	4-0
85	11	12	12	2-0
90	11	12	12	0-0

TABLE XXIII.

The Moon's Equatorial Horizontal Parallax, Semidiameter, and Horary Motion in her Orbit, at New and Full Moon; and the Semidiameter and Horary Motion of the Sun.

Argument. Moon's True Anomaly, or Sun's Mean Anomaly.							
Argu- ment.		Moon's Equato- rial Hori- zontal Parallax.	Moon's Semi- diameter.	Moon's Horary Motion.	Sun's Semi- diameter.	Sun's Horary Motion.	Argu- ment.
s.		M. s.	M. s.	M. s.	M. s.	M. s.	s.
O.	0°	61 23	16 44	38 13	16 18	2 33	XII. 0°
	6	61 22	16 43	38 11	16 18	2 33	24
	12	61 18	16 42	38 7	16 17	2 33	18
	18	61 12	16 41	37 59	16 17	2 33	12
	24	61 4	16 38	37 49	16 16	2 32	6
I.	0	60 53	16 35	37 36	16 15	2 32	XI. 0
	6	60 41	16 32	37 21	16 15	2 32	24
	12	60 26	16 28	37 3	16 13	2 32	18
	18	60 9	16 23	36 43	16 12	2 31	12
	24	59 51	16 19	36 21	16 11	2 31	6
II.	0	59 31	16 13	35 58	16 9	2 30	X. 0
	6	59 10	16 7	35 33	16 8	2 30	24
	12	58 49	16 2	35 7	16 6	2 29	18
	18	58 26	15 55	34 40	16 4	2 29	12
	24	58 3	15 49	34 14	16 3	2 28	6
III.	0	57 39	15 43	33 46	16 1	2 28	IX. 0
	6	57 16	15 36	33 19	15 59	2 27	24
	12	56 53	15 30	32 53	15 58	2 27	18
	18	56 30	15 24	32 27	15 56	2 26	12
	24	56 8	15 18	32 2	15 55	2 26	6
IV.	0	55 47	15 12	31 39	15 53	2 25	VIII. 0
	6	55 28	15 7	31 17	15 52	2 25	24
	12	55 10	15 2	30 56	15 51	2 25	18
	18	54 53	14 57	30 38	15 49	2 24	12
	24	54 38	14 53	30 22	15 48	2 24	6
V.	0	54 25	14 50	30 8	15 48	2 24	VII. 0
	6	54 15	14 47	29 56	15 47	2 23	24
	12	54 6	14 45	29 47	15 46	2 23	18
	18	54 0	14 43	29 40	15 46	2 23	12
	24	53 57	14 42	29 36	15 46	2 23	6
VI.	0	53 55	14 42	29 35	15 46	2 23	VI. 0

TABLE XXV.

TABLE XXVI.

Epochs of the Mean Longitude of the Sun's Perigee, including the Secular Variation of the Precession of the Equinoxes.

Mean Motion of the Sun's Perigee in Years, Months, and Days.

Years.	Longitude of Sun's Perigee.				Secular Variation of Precession of Equinoxes.
	s.	d.	m.	s.	s.
B. C. Old Style.					
800	7	25	1	10	— 60
700	7	26	43	20	57
600	7	28	25	33	56
500	8	0	7	47	53
400	8	1	50	4	— 50
300	8	3	32	24	49
200	8	5	14	45	46
100	8	6	57	9	44
A. C. Old Style.					
1	8	8	39	35	— 42
101	8	10	22	3	39
201	8	12	4	34	37
301	8	13	47	7	34
401	8	15	29	43	— 33
501	8	17	12	20	30
601	8	18	55	0	27
701	8	20	37	43	25
801	8	22	20	28	— 23
901	8	24	3	15	21
1001	8	25	46	4	18
1101	8	27	28	56	15
1201	8	29	11	51	— 14
1301	9	0	54	47	11
1401	9	2	37	46	8
1501	9	4	20	48	6
1601	9	6	3	52	— 4
1701	9	7	46	58	— 1
A. C. New Style.					
1501	9	4	20	46	— 6
1601	9	6	3	50	4
1701	9	7	46	56	— 1
1801	9	9	30	5	+ 1
1901	9	11	13	16	4
2001	9	12	56	30	

Years.	Motion of Sun's Perigee.			Months.	Motion of Sun's Perigee.		Days.	Motion of Sun's Perigee.
	d.	m.	s.		m.	s.		s.
1	0	1	2	January,	0	0	7	1
2	0	2	4	February,	0	5	13	2
3	0	3	6	March,	0	10	19	3
4	0	4	8	April,	0	15	25	4
5	0	5	9					
6	0	6	11	May,	0	20	31	5
7	0	7	13	June,	0	26		
8	0	8	15	July,	0	31		
9	0	9	17	August,	0	36		
10	0	10	19	September,	0	41		
20	0	20	38	October,	0	46		
30	0	30	57	November,	0	52		
40	0	41	16	December,	0	57		
50	0	51	35					
60	1	1	54					
70	1	12	13					
80	1	22	32					
90	1	32	51					
100	1	43	10					

TABLE XXVII.

The Sun's Declination for the Year 1801, with the Secular Variation.

Argument. Sun's True Longitude.										
	O.s. + VI.s. —		Secular Variation.	I.s. + VII.s. —		Secular Variation.	II.s. + VIII.s. —		Secular Variation.	
	D.	M.	M.	D.	M.	M.	D.	M.	M.	
0°	0	0·0	— 0·0	11	29·1	— 0·4	20	10·4	— 0·7	30
1	0	23·9	— 0·0	11	50·1	— 0·4	20	22·9	— 0·7	29
2	0	47·8	0·0	12	10·9	0·4	20	35·1	0·7	28
3	1	11·6	0·0	12	31·5	0·4	20	46·9	0·7	27
4	1	35·5	0·1	12	52·0	0·4	20	58·3	0·7	26
5	1	59·3	0·1	13	12·2	0·4	21	9·3	0·7	25
6	2	23·1	— 0·1	13	32·2	— 0·4	21	19·9	— 0·7	24
7	2	46·9	0·1	13	51·9	0·5	21	30·2	0·7	23
8	3	10·6	0·1	14	11·5	0·5	21	40·0	0·7	22
9	3	34·3	0·1	14	30·8	0·5	21	49·4	0·7	21
10	3	57·9	0·1	14	49·8	0·5	21	58·4	0·7	20
11	4	21·5	— 0·1	15	8·6	— 0·5	22	7·1	— 0·8	19
12	4	44·9	0·2	15	27·2	0·5	22	15·2	0·8	18
13	5	8·4	0·2	15	45·5	0·5	22	23·0	0·8	17
14	5	31·7	0·2	16	3·5	0·5	22	30·3	0·8	16
15	5	54·9	0·2	16	21·2	0·5	22	37·3	0·8	15
16	6	18·1	— 0·2	16	38·7	— 0·6	22	43·7	— 0·8	14
17	6	41·1	0·2	16	55·9	0·6	22	49·8	0·8	13
18	7	4·1	0·2	17	12·8	0·6	22	55·4	0·8	12
19	7	26·9	0·2	17	29·4	0·6	23	0·6	0·8	11
20	7	49·7	0·3	17	45·6	0·6	23	5·3	0·8	10
21	8	12·3	— 0·3	18	1·6	— 0·6	23	9·6	— 0·8	9
22	8	34·7	0·3	18	17·3	0·6	23	13·4	0·8	8
23	8	57·1	0·3	18	32·6	0·6	23	16·8	0·8	7
24	9	19·3	0·3	18	47·6	0·6	23	19·8	0·8	6
25	9	41·3	0·3	19	2·3	0·6	23	22·3	0·8	5
26	10	3·2	— 0·3	19	16·6	— 0·6	23	24·3	— 0·8	4
27	10	24·9	0·3	19	30·6	0·7	23	25·9	0·8	3
28	10	46·5	0·4	19	44·2	0·7	23	27·0	0·8	2
29	11	7·9	0·4	19	57·5	0·7	23	27·7	0·8	1
30	11	29·1	0·4	20	10·4	0·7	23	27·9	0·8	0
	XI.s. + V.s.			X.s. + IV.s.			IX.s. + III.s.			

Multiply the secular variation by the number of years between the given time and the year 1801, and divide the product by 100. If the given time be before 1801, change the sign of the secular variation.

TABLE XXVIII.

Equation of Time for converting Mean Time into Apparent Time for the Year 1801, with the Secular Variation.

Argument. Sun's True Longitude.										
O. ^s	I. ^s	II. ^s	III. ^s	IV. ^s	V. ^s	VI. ^s	VII. ^s	VIII. ^s	IX. ^s	X. ^s
Secular Variation.	Secular Variation.	Secular Variation.	Secular Variation.	Secular Variation.	Secular Variation.	Secular Variation.	Secular Variation.	Secular Variation.	Secular Variation.	Secular Variation.
M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.
0°	1	2	3	4	5	6	7	8	9	10
-7 36	+1 9	+3 49	-1 17	-6 1	-13 23	+7 37	+15 34	+13 36	+1 16	-11 25
-7 17	+3 122	+3 45	-1 31	-6 3	-13 7	+7 58	+15 43	+13 20	+0 46	-11 42
6 58	+3 135	+3 41	-1 44	-6 4	-13 151	+8 19	+15 50	+13 3	+0 17	-11 58
6 40	+3 148	+3 36	-1 58	-6 5	-13 134	+8 39	+15 56	+12 45	+0 13	-12 15
6 21	+3 2 0	+3 30	-2 11	-6 6	-13 117	+8 59	+16 1	+12 26	+0 42	-12 30
6 2	+3 212	+3 24	-2 24	-6 6	-13 059	+9 19	+16 5	+12 6	+1 12	-12 44
-5 43	+2 222	+3 17	-2 37	-6 5	-12 041	+9 39	+16 9	+11 46	+1 41	-12 57
-5 24	+2 232	+3 10	-2 50	-6 3	-12 023	+9 59	+16 12	+11 25	+2 10	-13 9
-5 5	+2 241	+3 2	-3 3	-6 0	-12 0	+10 19	+16 14	+11 4	+2 39	-13 21
-4 46	+2 250	+3 254	-3 15	-6 56	-12 015	+10 38	+16 15	+10 42	+3 7	-13 32
-4 27	+2 258	+3 245	-3 27	-6 52	-12 034	+10 57	+16 16	+10 19	+3 36	-13 42
-4 8	+3 6	+2 36	-3 39	-6 47	-12 054	+11 15	+16 16	+9 56	+4 4	-13 51
-3 50	+3 14	+2 27	-3 51	-6 42	-11 114	+11 33	+16 15	+9 32	+4 32	-13 59
-3 31	+3 22	+2 17	-4 2	-6 36	-11 135	+11 51	+16 13	+9 8	+4 59	-14 7
-3 13	+3 29	+2 7	-4 13	-6 29	-11 156	+12 8	+16 10	+8 43	+5 26	-14 14
-2 54	+3 35	+2 156	-4 23	-6 22	-11 217	+12 25	+16 7	+8 18	+5 52	-14 20
-2 36	+3 40	+1 45	-4 33	-6 14	-11 238	+12 41	+16 3	+7 52	+6 18	-14 25
-2 18	+3 44	+1 33	-4 43	-6 6	-11 259	+12 57	+15 58	+7 25	+6 44	-14 29
-2 0	+3 48	+1 20	-4 52	-6 47	-11 320	+13 13	+15 52	+6 58	+7 9	-14 33
-1 42	+3 52	+1 8	-5 1	-6 47	-11 341	+13 29	+15 45	+6 31	+7 34	-14 37
-1 25	+3 54	+0 56	-5 9	-6 36	-11 42	+13 44	+15 37	+6 3	+7 58	-14 39
-1 8	+3 56	+0 43	-5 17	-6 25	-11 424	+13 58	+15 28	+5 35	+8 22	-14 40
-0 52	+3 58	+0 30	-5 24	-6 14	-11 445	+14 11	+15 19	+5 8	+8 45	-14 39
-0 36	+3 59	+0 17	-5 31	-6 4	-11 457	+14 23	+15 9	+4 40	+9 7	-14 39
-0 20	+3 59	+0 4	-5 37	-6 30	-11 466	+14 35	+14 58	+4 11	+9 29	-14 38
-0 4	+3 59	+0 9	-5 43	-6 37	-11 466	+14 46	+14 46	+3 42	+9 50	-14 36
+0 11	+3 58	+0 23	-5 48	-6 23	-11 461	+14 57	+14 34	+3 13	+10 10	-14 35
+0 26	+3 57	+0 36	-5 52	-6 13	-11 461	+15 7	+14 21	+2 44	+10 30	-14 32
+0 41	+3 55	+0 50	-5 55	-6 24	-11 461	+15 17	+14 7	+2 15	+10 49	-14 28
+0 55	+3 52	+1 3	-5 58	-6 39	-11 461	+15 26	+13 52	+1 45	+11 7	-14 23
+1 9	+3 49	+1 17	-6 1	-6 23	-11 461	+15 34	+13 36	+1 16	+11 25	-14 18

Multiply the secular variation by the number of years between the given time and the year 1801, and divide the product by 100. If the given time be before 1801, change the sign of the secular variation.

SECT. II.—*Application of the Tables, and Projection of Eclipses.*

PROBLEM I.—*To calculate the time of true new or full moon for any period within the limits of the nineteenth century.*

Precept 1. Write out the time of mean new moon in January for the proposed year from Table I., together with the mean anomalies of the moon and sun, and the moon's mean distance from her ascending node, applying to each of these quantities the secular equation found by its side by addition or subtraction, according as it has the sign + or —. If you want the time of full moon in January, add the half-lunation at the foot of Table IV., with its anomalies, &c. to the former numbers if the new moon falls before the 15th of January; but if it falls after, subtract the half-lunation, with the anomalies, &c. belonging to it, from the former numbers, and write down the respective sums or remainders.

2. In these additions or subtractions, observe that 60 seconds make a minute, 60 minutes make a degree, 30 degrees make a sign, and 12 signs make a circle. When you exceed 12 signs in addition, reject 12, and set down the remainder. When the number of signs to be subtracted is greater than the number you subtract from, add 12 signs to the lesser number, and then you will have a remainder to set down. In the tables, signs are marked S, degrees D, minutes M, and seconds S.

3. When the required new or full moon is in any given month after January, write out from Table IV. such one of the mean lunations, with the anomalies, &c. as, added to the time of mean new or full moon in January, will make the mean new or full moon to fall within the given month, setting them below the number taken out for January.

4. Add all these together, and in leap-years (which in Table I. have the letter B annexed to them) subtract one day from the time of mean new or full moon when it happens after 28th February. You will then have the time of the required mean new or full moon, with the mean anomalies, and the moon's mean distance from the ascending node, which are the arguments for finding the proper equations.

5. With the signs and degrees of the moon's mean anomaly enter Table V., and therewith take out the first equation for reducing the mean syzygy to the true; taking care to make proportions in the table for the odd minutes and seconds of anomaly, as the table gives the equation only to whole degrees.

Observe in this and every other case of finding equations, that, if the signs are at the head of the table, their degrees are at the left hand, and are reckoned downwards; the equation being in the body of the table under or over the signs in a collateral line with the degrees. The signs + and — at the head or foot of the tables where the signs are found, show whether the equation is to be added to the time of mean new or full moon, or to be subtracted from it.

6. With the signs and degrees of the sun's mean anomaly enter Table VI. and take out the second equation for reducing the time of mean to that of new or full moon,

with a proportional part of its secular variation in the column adjoining, corresponding to the number of years elapsed since 1801, the whole variation being adapted for a period of 100 years.

7. Add together the mean anomalies of the sun and moon, and with the sum enter Table VII. and take out the third equation. For this and the following equations it will be sufficient to compute the arguments to minutes, neglecting the seconds.

8. Subtract the sun's mean anomaly from the moon's mean anomaly, and with the remainder enter Table VIII. and take out the fourth equation.

9. Subtract the moon's mean anomaly from twice the moon's distance from the ascending node, and with the remainder enter Table IX. and take out the fifth equation.

10. The moon's mean distance from the ascending node is the argument of Table X., with which take out the sixth equation.

11. To twice the moon's mean anomaly add the sun's mean anomaly, and with the sum enter Table XI. and take out the seventh equation.

12. From twice the moon's mean anomaly subtract the sun's mean anomaly, and with the remainder enter Table XII. and take out the eighth equation.

13. These are all the equations for reducing the time of mean new moon to the time of true new moon; but for full moon other two equations are required, the argument for equation ninth being the moon's mean anomaly, which equation is exhibited in Table XIII.; and the argument of the tenth equation being the sun's mean anomaly, the equation being exhibited in Table XIV.

14. Add together the equations which have the sign of addition, and also those which have the sign of subtraction, and subtract the lesser sum from the greater, giving to the remainder the sign of the greater; and add or subtract the remainder, according as its sign denotes, to or from the time of mean new or full moon, and you have the time of true new or full moon required.

These tables are adapted to the meridian of Greenwich observatory; and for any other place, its longitude in time is to be added to or subtracted from the time given by the tables, according as it is to the east or west of Greenwich, and the time as reckoned at the given place is obtained. The tables begin the day at noon, and reckon forward from thence to the noon following. Thus January the 31st, at 22 hours 30 minutes 25 seconds of tabular time, is February 1st (in common reckoning), at 30 minutes 25 seconds after 10 o'clock in the morning. It is to be further observed, that the time obtained from the tables is mean time, or that shown by a well-regulated clock or watch. But to make it agree with solar or apparent time, or that given by a sun-dial, which is necessary in the computation of solar eclipses, you must apply the equation of time contained in Table XXVIII. as afterwards directed.

The method of calculating the time of any new or full moon, without the limits of the nineteenth century, will be shown farther on; and a few examples compared with the precepts will make the whole work plain.

Required the Time of True New Moon in May 1836 at Edinburgh, long. 0 hours 12 minutes 44 seconds west of Greenwich.

EQUATIONS.

EXAMPLE II.

Required the Time of True Full Moon in September 1830 at Greenwich.

[illegible]

EQUATIONS.

	s.	D.	M.	s.	+	—
Argument I.	10	8	1	20	H. M. S. 7 21 32	H. M. S.
II.	8	1	23	24		3 38 33
Secular variation.....					10	
III.	6	9	24		1 10	
IV.	2	6	38		9 43	
V.	1	24	40		2 8	
VI.	0	1	21		5	
VII.	4	17	25			24
VIII.	0	14	39			3
IX.	10	8	1			1 9
X.	8	1	23			29
					+ 7 34 48	— 3 40 38
					— 3 40 38	
Sum of equations.....					+ 3 54 10	

PROBLEM II.—To calculate the time of new and full moon in a given year and month of any particular century between the Christian era and the nineteenth century.

Note.—Prior to the sixteenth century the times are

supposed to be reckoned according to the Julian calendar, or old style. Between it and the nineteenth century they may be reckoned according to either the Julian or Gregorian calendar, or old or new style.

Precept 1. Find a year of the same number in the nineteenth century, with that of the year in the century proposed, and take out the time of mean new moon in January for that year, with the mean anomalies, and the moon's mean distance from the node at that time, as already taught, neglecting the secular equations contained in Table I.

Precept 2. Take from Table II. as many complete centuries of years having the sign — prefixed, and titled either old style or new style, according to the given date, as, when subtracted from the above said year in the nineteenth century, will answer to the given year, and take out the time of mean new moon and its anomalies, &c. belonging to the said centuries, and add them to those for the year in the nineteenth century, and the sums, after applying to them the secular equations taken from Table III., making proportions for the odd years, will be the times and anomalies, &c. of mean new moon in January or February, according as the time is less or more than 31 days, in the given year of the century proposed. Then work in all respects for the time of true new or full moon, as shown in the above precepts and examples.

EXAMPLE III.

Required the True Time of New Moon in July 1339, Old Style.

		Time of New Moon.	Moon's Mean Anomaly.	Sun's Mean Anomaly.	Moon's Mean Distance from Ascending Node.
		D. H. M. S.	S. D. M. S.	S. D. M. S.	S. D. M. S.
1839		14 16 41 35	9 10 4 21	0 13 47 38	9 25 44 34
— 500		25 8 52 43	7 4 4 42	1 11 36 18	2 24 9 33
1339		40 1 34 18	4 14 9 3	1 25 23 56	0 19 54 7
Secular equations.....		— 7 39	+ 13 44	— 36	— 2 43
Five lunations.....	May...	40 1 26 39	4 14 22 47	1 25 23 20	0 19 51 24
		27 15 40 14	4 9 5 4	4 25 31 37	5 3 21 8
Equations.....	July...	6 17 6 53	8 23 27 51	6 20 54 57	5 23 12 32
		+ 8 26 6			
Time of true new moon..	July...	7 1 32 59			

EQUATIONS.

	s.	D.	M.	s.	+	—
Argument I.	8	23	27	51	H. M. S. 9 50 21	H. M. S.
II.	6	20	54	57		1 27 56
Secular variation.....						1 0
III.	3	14	23			6 52
IV.	2	2	33		9 23	
V.	2	22	57		2 36	
VI.	5	23	13			27
VII.	0	7	51			5
VIII.	10	26	1		6	
					+ 10 2 26	— 1 36 20
					— 1 36 20	
Sum of equations.....					+ 8 26 6	

PROBLEM III.—To calculate the true time of new or full moon in any given year and month before the Christian era.

Precept 1. Find a year in the nineteenth century which, being added to the given number of years before Christ diminished by one, shall make a number of complete centuries.

2. Find this number of centuries in Table II. and add the time and anomalies belonging to it to those of the above-found year of the nineteenth century, applying the secular equations for the given year in Table III., and the sums will denote the time and anomalies, &c. of mean new moon in January or February of the given year before Christ. Then for the true time of new or full moon proceed as above taught, for any year between the Christian era and the nineteenth century, observing that the given year before Christ is or is not leap-year, according as the above-mentioned year in the nineteenth century is leap-year or not.

EXAMPLE IV.

Required the True Time of New Moon in September 610 before Christ.

		Time of New Moon.				Moon's Mean Anomaly.				Sun's Mean Anomaly.				Moon's Mean Distance from Ascending Node.			
		D.	H.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.
1891.....		9	20	44	18	10	20	20	33	0	8	32	8	7	6	53	20
— 2500.....		27	4	43	18	7	11	18	23	2	2	29	56	8	27	26	33
610 B. C.....		37	1	27	36	6	1	38	56	2	11	2	4	4	4	19	53
Secular equations.....		—3	20	0		+ 5	58	37		—16	7			—1	10	56	
Eight lunations.....	August	36	22	7	36	6	7	37	33	2	10	45	57	4	3	8	57
		24	5	52	23	6	26	32	7	7	22	50	35	8	5	21	48
Equations	Sept...	30	3	59	59	1	4	9	40	10	3	36	32	0	8	30	45
		—8	41	51													
Time of true new moon..	Sept...	29	19	18	18												

EQUATIONS.

	S.	D.	M.	S.	+	H.	M.	S.	—	H.	M.	S.
Argument I.	1	4	9	40					5	9	13	
II.	10	3	36	32					3	32	36	
Secular variation.....									12	51		
III.	11	7	46			2	41					
IV.	3	0	33			10	35					
V.	11	12	51						46			
VI.	0	8	31			— 34			7			
VII.	0	11	56						8			
VIII.	4	4	42									
						+ 0	13	50	— 8	55	41	
									+ 0	13	50	
Sum of equations.....									— 8	41	51	

PROBLEM IV.—To calculate the time of true new or full moon, according to the Gregorian calendar or new style, in any given year or month of the 20th or 21st century.

Precept 1. Find a year of the same number in the nineteenth century with that of the year proposed, and take out the mean time and anomalies, &c. of new moon for that year in Table I., omitting the secular equations.

2. Take so many years from Table II. having the sign + prefixed, as, when added to the above-mentioned year in the nineteenth century, will answer to the given year in which the new or full moon is required; and take out the time of new moon, with its anomalies, for these complete centuries.

3. Add these together, and to the sum apply the secular equations for the given year found in Table III., then work in all respects as above shown.

EXAMPLE V.

Required the Time of True New Moon in August 1999.

		Time of New Moon.				Moon's Mean Anomaly.				Sun's Mean Anomaly.				Moon's Mean Distance from Ascending Node.			
		D.	H.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.	S.	D.	M.	S.
1899		11	9	25	2	11	26	12	58	0	9	57	56	0	13	16	14
+ 100		5	8	7	5	8	15	30	40	0	3	19	16	4	19	26	11
1999		16	17	32	7	8	11	43	38	0	13	17	12	5	2	42	25
Secular equations.....				—1	25			+ 2	32			—7				—30	
Seven lunations	July....	16	17	30	42	8	11	46	10	0	13	17	5	5	2	41	55
		25	17	8	20	6	0	43	6	6	23	44	16	7	4	41	35
Equations	August	11	10	39	2	2	12	29	16	7	7	1	21	0	7	23	30
		—11	37	28													
Time of true new moon..		10	23	1	34												

EQUATIONS.

	S. D. M. S.	+	—
Argument I.	2 12 29 16	H. M. S.	H. M. S.
II.	7 7 1 21		9 8 24
Secular Variation.....		44	2 28 47
III.	9 19 31	6 42	
IV.	7 5 28		6 8
V.	10 2 18		2 13
VI.	0 7 23	0 30	
VII.	0 2 0		1
VIII.	9 17 57	9	
		+ 0 8 5	— 11 45 33
			+ 0 8 5
Sum of equations.....			— 11 37 28

PROBLEM V.—To find the true anomalies of the sun and moon, and the moon's true distance from the ascending node at the true time of new or full moon.

With the sum of equations already found for reducing the time of mean new or full moon to that of the true, enter Table XV., and take therefrom the sun's mean motion from the moon's perigee, the change of the sun's mean anomaly, and the sun's mean motion from the ascending node, and apply these quantities to the mean anomalies and mean distance from the node at the time of mean new or full moon by addition or subtraction, according as the sum of the equations has the sign + or —. Then with the sun's corrected mean anomaly as argument, take from Table XVI. the equation of the sun's centre, correcting it for the secular variation as directed at the bottom of the table, and add or subtract the same to or from the corrected mean anomalies and mean distance from the node, and there will be obtained the true anomalies of the sun and moon, and the moon's true distance from the ascending node at the time of true new moon or full moon.

EXAMPLE VI.

Required the True Anomalies of the Sun and Moon, and the Moon's True Distance from the Ascending Node at the time of True New Moon in 1836.

The Sum of Equations is — 2h. 24m. 2s.												
	Sun's Mean Motion from Moon's Perigee.				Sun's Mean Anomaly.				Sun's Mean Motion from Ascending Node.			
	S.	O.	M.	S.	S.	O.	M.	S.	S.	O.	M.	S.
2 Hours.....	0	0	4	22	0	0	4	56	0	0	5	12
24 Minutes.....				52				59			1	2
2 Seconds.....				0				0				0
			— 5	14			— 5	55			— 6	14
Mean anomalies, &c.....	4	28	6	57	4	13	19	2	0	3	36	53
	4	28	1	43	4	13	13	7	0	3	30	39
Equation of sun's centre.....		+ 1	22	57		+ 1	22	57		+ 1	22	57
Secular variation.....			— 4				— 4				— 4	
	4	29	24	36	4	14	36	0	0	4	53	32
	Moon's True Anomaly,				Sun's True Anomaly,				Moon's True Distance from Ascending Node,			
At True New Moon.												

Elements for the Projection of Solar Eclipses.

When at the time of true new moon the moon's true distance from the ascending node is between $11^{\circ} 11' 50''$ and $0^{\circ} 18' 10''$, or $5^{\circ} 11' 50''$ and $6^{\circ} 18' 10''$, there may at that time be an eclipse of the sun to some place on the earth's surface; but if it is beyond those limits there can be no eclipse. At the new moon in May 1836, the moon's distance from the node being within the limits, there may be an eclipse of the sun at that time.

It being ascertained that there may be an eclipse, the elements for predicting it are to be obtained as explained in the following example of the solar eclipse in May 1836, which is to be predicted, as it will happen at Edinburgh, in latitude $55^{\circ} 57' N$.

I. The moon's latitude at the true time of new moon. The

moon's true distance from the ascending node at the time of true new moon is the argument of Table XVII.; the moon's true anomaly *minus* her true distance from the ascending node is the argument of Table XVIII.; this argument *plus* the moon's true anomaly is the argument of Table XIX.; the moon's true anomaly *plus* her true distance from the ascending node is the argument of Table XX.; the sun's true anomaly *plus* the moon's true distance from the ascending node is the argument of Table XXI.; and the sun's true anomaly *minus* the moon's true distance from the ascending node is the argument of Table XXII. With these arguments enter the respective tables, and take out the proper quantities, and add together such as have the sign +, and also such as have the sign —, and the difference of the two sums is the moon's latitude required, north if the greater sum has the sign +, south if it has —.

Practical Astronomy. *Example.* The Moon's Latitude at the time of true New Moon in May 1836. *V. The moon's semidiameter is likewise obtained in Table XXII., with her true anomaly as argument. Hence, moon's semidiameter = 14' 50".* Practical Astronomy.

	S.	D.	M.	S.	+	D.	M.	S.	-	S.
Arg. Table XVII.	0	4	53	32		0	25	47		
..... XVIII.	4	24	31						7	
..... XIX.	9	23	56						23	
..... XX.	5	4	18					7		
..... XXI.	4	19	30					13		
..... XXII.	4	9	42					25		
						+	0	26	32	- 30
								- 30		
Moon's latitude north.....						+	0	26	2	

II. The inclination of the moon's relative orbit to the ecliptic is found in Table XVII., with the moon's true distance from the ascending node for argument. In the present instance the inclination is 5° 43', left, signifying that the axis of the moon's orbit is to the left hand of the northern axis of the ecliptic.

III. The semidiameter of the earth's disk is equal to the difference of the moon's horizontal parallax corrected for the latitude of the given place, and the sun's horizontal parallax, which may always be assumed equal to nine seconds. The moon's equatorial horizontal parallax is found in Table XXIII., with her true anomaly for argument; and the correction to be subtracted therefrom is obtained in Table XXIV., with the latitude of the place and equatorial parallax as joint arguments. Thus, in the present instance, the moon's equatorial horizontal parallax is.....54' 26" The correction to be subtracted..... 8"

Leaving for reduced horizontal parallax.....54' 18" which being again diminished by the sun's horizontal parallax, there remains 54' 9" for the semidiameter of the earth's disk.

IV. The sun's semidiameter is also obtained in Table XXII., with his mean anomaly as argument. We have, therefore, sun's semidiameter 15' 51".

	S.	D.	M.	S.		D.	M.	S.
Sun's true longitude.....	1	24	42	33	Declination	+	18	58.0
Secular variation.....			0.6	× 35				- 0.2
				100	=			
Sun's declination, north.....						+	18	57.8

IX. The apparent time of new moon. The mean time of new moon, already found and reduced to the place for which the prediction is to be made, is to be converted into apparent time, by applying thereto, according to the sign,

the equation of time found in Table XXVIII., with the sun's true longitude for argument, and corrected for the secular variation given in the same table, as in the following example :

	H.	M.	S.
Mean time of true new moon at Edinburgh on May 15, 1836.....	1	51	11
Sun's true longitude 1 24 43			
Equation of time, +3 59			
Secular variation..... - 10s × 35			
			100
			=
			- 3
Apparent time of true new moon.....	1	55	7

X. The reduced latitude of the given place is obtained by subtracting from the true latitude the correction in the last column of Table XXIV. answering to the latitude. In this particular case,

Edinburgh being in north latitude.....	55° 57'
The correction is.....	10.8
Reduced latitude.....	55° 46.2

To Project an Eclipse of the Sun geometrically.

Take from a scale of any convenient length as many equal parts as the semidiameter of the earth's disk contains minutes of a degree, which for Edinburgh at the time of the eclipse in May 1836 is $54' 10''$, or $54\frac{1}{6}'$. Then with this quantity as a radius describe the semicircle AHB upon the centre C (Plate XCIV. fig. 136); which semicircle shall represent the northern half of the earth's enlightened disk as seen from the sun. If the given place were in south latitude, the southern half of the earth's disk must be represented.

Upon the centre C raise the straight line CH perpendicular to the diameter ACB; so ACB shall be a part of the ecliptic, and CH its axis.

Being provided with a sector,¹ open it to the radius CA in the line of chords; and taking from thence the chord of the sun's greatest declination or the obliquity of the ecliptic for the given time (in the present instance $23^\circ 28'$) in your compasses, set it off both ways from H to *g*, and to *h* in the periphery of the semi-disk; and draw the straight line *gVh*, in which the north pole of the disk will be always found.

When the sun's longitude is between O^s . and VI^s . the north pole of the earth is enlightened by the sun; but whilst the sun is in the other six signs, the south pole is enlightened and the north pole is in the dark.

And when the sun's longitude is between IX^s . and III^s . the northern half of the earth's axis C XII. P lies to the right hand of the axis of the ecliptic as seen from the sun; and to the left hand while the sun is in the other six signs. It is evident that a contrary rule prevails with regard to the southern half of the earth's axis.

Open the sector till the radius of the sines be equal to the length of V^h , and take the sine of the difference of the sun's longitude from III^s . or IX^s , whichever it is nearest (in the present instance $35^\circ 17'$), in your compasses from the line of the sines, and set off that distance from V to P in the line *gVh*, because the northern half of the earth's axis lies to the right hand of the axis of the ecliptic in this case; and draw the straight line C XII. P for the earth's axis, of which P is the north pole. If the earth's axis had lain to the left hand of the axis of the ecliptic, the distance VP would have been set off from V towards *g*.

To draw the parallel of latitude of the given place, Edinburgh, or the path of that place, on the earth's enlightened disk, as seen from the sun from sunrise till sunset, take the following method:—

Find the sum and difference of the reduced latitude $55^\circ 46'$ and the sun's declination $18^\circ 58'$, which are $74^\circ 44'$ and $36^\circ 48'$. Take these arcs from the line of sines on the sector, CA being radius, and set them off from C to the two points, each marked XII. in the line of the earth's axis.

Bisect XII. — XII., and through the point K draw the line VI. K VI. perpendicular to the axis. Then, making CA or CB the radius of a line of sines on the sector, take the co-latitude of Edinburgh, $34^\circ 14'$, from the sines in your compasses, and set it both ways from K to VI. and VI. These hours will be just in the edge of the disk at the equinoxes; but at no other time in the whole year.

With the extent K VI. taken into your compasses, set one foot in K as a centre, and with the other foot describe the semicircle VI., 7, 8, 9, 10, &c., and divide it into 12 equal parts. Then from these points of division draw lines parallel to the earth's axis C XII. P.

With the extent K XII. as a radius, describe the quadrant arc XII. *f*; and divide it into six equal parts, as XII. *a*, *ab*, *bc*, *cd*, *de*, and *ef*, and through the division points, *a*, *b*, *c*, *d*, *e*, draw the lines VII. *e* V., VIII. *d* IV., IX. *c* III., X. *b* II., and XI. *a* I., all parallel to VI. K VI., and meeting the former lines in the points VII., VIII., IX., X., XI., V., IV., III., II., and I.; which points shall mark the several situations of Edinburgh on the earth's disk, at these hours respectively as seen from the sun; and the elliptic curve VI., VII., VIII., &c. being drawn through these points, shall represent the parallel of latitude, or path of Edinburgh, as seen from the sun from six in the morning to six in the afternoon. On continuing the lines VII. *p*, VIII. *o*, &c. IV. *u*, V. *x*, &c. on the other side of VI. K VI., and setting off *p* V. equal to VII. *p*, *o* IV. equal to VIII. *o*, &c., and continuing the elliptic curve through the points V. IV. &c., VII. VIII. &c., the path of Edinburgh, as seen from the sun before six in the morning and after six in the afternoon, will be had; but it is needless to draw the curve farther than the points where it meets the periphery of the earth's disk, which represent the times of sunrise and sunsetting.

N. B. If the sun's declination had been south, the diurnal path of Edinburgh would have been on the upper side of the line VI. K VI. If the latitude of the given place were south, in which case the southern half of the earth's disk would be represented, the diurnal path between six in the morning and six in the afternoon would be between the line VI. K VI. and the centre of the disk, when the sun's declination was south, and the contrary when north. It is requisite to divide the horary spaces into quarters as in the figure, and if possible into minutes also.

In the present case the northern half of the axis of the moon's relative orbit lies to the left hand of the axis of the ecliptic. Make CB the radius of a line of chords on the sector, and taking therefrom the chord of $5^\circ 43'$, the inclination of the moon's relative orbit to the ecliptic, set it off from H to M on the left hand of CH, the axis of the ecliptic; then draw CM for the axis of the moon's orbit, and take the moon's latitude $26' 2''$ from the scale CA in your compasses, and set it from C to *y* in the line CH, and through *y* draw the straight line NyS at right angles to the axis of the moon's orbit CM for the path of the penumbra's centre over the earth's disk.

Take the moon's horary motion from the sun, $27' 44''$, in your compasses, from the scale CA (every division of which is a minute of a degree), and with that extent make marks along the path of the penumbra's centre, and divide each space from mark to mark into 60 equal parts or horary minutes by dots; and set the hours to every 60th minute in such a manner that the dot signifying the instant of new moon by the tables may fall into the point Z, half-way between the axis of the moon's orbit and the axis of the ecliptic; and then the rest of the dots will show the points of the earth's disk, where the penumbra's centre is at the instants denoted by them in its transit over the earth.

Apply one side of a square to the line of the penumbra's path, and move the square backwards and forwards, until the other side of it cuts the same hour and minute (as at 3 hours and $2\frac{1}{2}$ minutes) both in the path of Edinburgh and in the path of the penumbra's centre; and the particular minute or instant so pointed out is the instant of the greatest obscuration of the sun, at the place for which the construction is made, namely, Edinburgh in the present example.

¹ Although a sector be a convenient instrument in these projections, yet it is not absolutely necessary. The intelligent student will be able to lay off an arc of any number of degrees, also to make an angle of a given number of degrees, in various ways.

Practical Astronomy. Take the sun's semidiameter, $15' 51''$, in your compasses, from the scale CA, and setting one foot on the path of Edinburgh, at the point answering to the instant of the greatest obscuration, namely, at $2\frac{1}{2}$ minutes past three, with the other foot describe the circle UY, which represents the sun's disk as seen from Edinburgh at the greatest obscuration. Then take the moon's semidiameter, $14' 50''$, in your compasses, from the same scale, and setting one foot on the path of the penumbra's centre at the point $2\frac{1}{2}$ minutes past three, describe the circle TX for the moon's disk as seen from Edinburgh at the time when the eclipse is at the greatest, and the portion of the sun's disk which is hid or cut off by the moon's will show the quantity of the eclipse at that time; which quantity may be measured on a line equal to the sun's diameter, and divided into 12 equal parts for digits. As the moon's disk is entirely contained within the sun's, the eclipse as seen from Edinburgh will be annular.

Lastly, take the sum of the semidiameters of the sun and moon, $30' 41''$, from the scale CA, in your compasses; and setting one foot in the line of the penumbra's centre path, on the left hand from the axis of the ecliptic, direct the other foot toward the path of Edinburgh, and carry that extent backwards and forwards till both the points of the compasses fall into the same instants in both the paths, and these instants will denote the time when the eclipse begins at Edinburgh. Then do the like on the right hand of the axis of the ecliptic; and where the points of the compasses fall into the same instants in both the paths, they will show at what time the eclipse ends at Edinburgh.

Practical Astronomy. These trials give $35\frac{1}{2}$ minutes after one in the afternoon for the beginning of the eclipse at Edinburgh at the points N and O, $2\frac{1}{2}$ minutes after three for the time of greatest obscuration, and $23\frac{1}{2}$ minutes after four at R and S for the time when the eclipse ends, according to apparent time. To have the mean time, or that shown by well-regulated clocks and watches, apply the equation of time in the contrary manner to that used for converting the mean time of new moon into apparent time. Therefore, in the present instance, subtract 3 minutes 56 seconds, or 4 minutes approximately, from the apparent times, and we have

	H.	M.	P. M.
Beginning of eclipse at Edinburgh,	1	$31\frac{1}{2}$	—
Greatest obscuration	2	$58\frac{1}{2}$	—
End of eclipse.....	4	$19\frac{1}{2}$	—
all according to mean time.			

The Projection of Lunar Eclipses.

When the moon's mean distance from either of her nodes at the time of mean full moon is less than $13^{\circ} 21'$ there may be an eclipse of the moon; but if greater, there cannot be an eclipse.

We find by Example II. that at the time of mean full moon in September 1830, the moon's mean distance from the descending node is only $1^{\circ} 20' 33''$, which being so much less than the limit, there will then be an eclipse.

By Problem V. find the true anomalies of the sun and moon, and the moon's true distance from the ascending node, at the true time of full moon.

Sum of Equations, + 3h. 54m. 10s.												
	Sun's Mean Motion from Moon's Perigee.				Sun's Mean Anomaly.				Sun's Mean Motion from Ascending Node			
	s.	o.	m.	s.	s.	o.	m.	s.	s.	o.	m.	s.
3 Hours.....	0	0	6	33	0	0	7	23	0	0	7	47
54 Minutes.....			1	58			2	13			2	20
10 Seconds.....				0				0				0
Mean anomalies, &c.....	10	8	+ 8	31	8	1	+ 9	36	6	1	+ 10	7
			1	20			23	24			20	33
Equation of sun's centre.....	10	8	9	51	8	1	33	0	6	1	30	40
Secular variation.....			— 1	40			— 1	40			— 1	40
				30				30				30
				+ 4				+ 4				+ 4
	10	6	29	25	7	29	52	34	5	29	50	14
	Moon's True Anomaly,				Sun's True Anomaly,				Moon's True Distance from Ascending Node,			
At True Full Moon.												

The elements for constructing an eclipse of the moon are eight in number, as follows:

1. The true time of full moon, and at that time; 2. the moon's horizontal parallax; 3. the sun's semidiameter; 4. the moon's; 5. the semidiameter of the earth's shadow at the moon; 6. the moon's latitude; 7. the angle of the moon's visible path with the ecliptic; 8. the moon's true horary motion from the sun. Therefore,

1. *To find the true time of full moon.* Work as already taught in the precepts. Thus we have the true time of full moon in September 1830 (see Example II.) to be the 2d day at $10^h. 36^m. 47^s.$ mean time at Greenwich.

2. *To find the moon's horizontal parallax.* Enter Table XXIII. with the moon's true anomaly $10^{\circ} 6' 29'' 25''$, and thereby take out her horizontal parallax; which, by

making the requisite proportions, will be found to be $59' 52''$.

3. 4. *To find the semidiameters of the sun and moon.* Enter Table XXIII. with the sun's mean anomaly and moon's true anomaly ($8^{\circ} 1' 33'' 0''$ and $10^{\circ} 6' 29'' 25''$), and thereby take out their respective semidiameters, the sun's $15' 54''$, and the moon's $16' 19''$.

5. *To find the semidiameter of the earth's shadow at the moon.* Add the sun's horizontal parallax, which is always $9''$, to the moon's, which in the present case is $59' 52''$; the sum is $60' 1''$, from which subtract the sun's semidiameter, $15' 54''$, and the remainder, $44' 7''$, being increased by $50''$ for the effect of the earth's atmosphere, we have $44' 57''$ for the semidiameter of the earth's shadow, which the moon then passes through.

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6. *To find the moon's latitude.* Proceed as already directed under the prediction of solar eclipses. Thus,

	s.	°	'	"	+ s.	- s.
Argument, Table XVII.	5	29	50	14	52	
XVIII.	4	6	39			10
XIX.	2	13	9		25	
XX.	4	6	20		14	
XXI.	1	29	43		17	
XXII.	2	0	2		28	
					+ 2 16	- 10
					- 10	

Moon's latitude north + 2 6

7. *To find the angle of the moon's visible path with the ecliptic.* Enter Table XVII. with the moon's true distance from the ascending node for argument, and the angle is found to be $5^{\circ} 44'$, left, signifying that the axis of the moon's orbit is to the left hand of the northern axis of the ecliptic.

8. *To find the moon's true horary motion from the sun.* With the true anomaly of the moon and the mean anomaly of the sun, take out their horary motions from Table XXIII., and the sun's horary motion subtracted from the moon's leaves remaining the moon's true horary motion from the sun; in the present case $33' 58''$.

These elements being found for the construction of the moon's eclipse in September 1830, proceed as follows:

Draw the line ACB for part of the ecliptic, and CD perpendicular thereto for the northern part of its axis, the moon having north latitude. (Plate XCIV. fig. 137.)

Add the semidiameters of the moon's and earth's shadow together, which in the eclipse make $61' 16''$; and take this in your compasses, from a scale of equal parts, and setting one foot on the point C as a centre, with the other foot describe the arch ADB, in one point of which the moon's centre will be at the beginning of the eclipse, and in another at the end thereof.

Take the semidiameter of the earth's shadow, $44' 57''$, in your compasses, from the scale, and setting one foot in the centre C, with the other foot describe the semicircle KLM for the northern half of the earth's shadow; because the moon's latitude is north in this eclipse.

Subtract the semidiameter of the moon from the semidiameter of the earth's shadow, and the remainder is $28' 38''$, which take in your compasses from the scale, and setting one foot on the point C as a centre, with the other foot describe the arch OPQ; in one point of which the moon's centre will be at the beginning of total darkness, and in another at the end thereof.

Draw the line CE on the left hand of the northern axis

of the ecliptic, and making an angle of $5^{\circ} 44'$ therewith, which line represents the northern part of the axis of the moon's orbit, the moon's latitude being north.

Take the moon's latitude, $2' 6''$, from the scale with your compasses, and set it from C to G in the axis of the ecliptic, and through the point G draw the straight line RSGTU, at right angles to the axis of the moon's orbit, for the path of the moon's centre. Then F, in the line CE, is the point in the earth's shadow where the moon's centre is at the middle of the eclipse; G, the point where her centre is at the instant of her ecliptical conjunction; and the middle between them, the point where her centre is at the time of true full moon by the tables.

Take the moon's horary motion from the sun, $33' 58''$, in your compasses, from the scale, and with that extent make marks along the line of the moon's path; then divide each space from mark to mark into 60 equal parts or horary minutes, and set the hours to the proper dots, in such a manner, that the dot signifying the instant of full moon (36 minutes and 47 seconds after ten) may be midway between the points F and G.

The point U, where the moon's path intersects on the right hand the arch described with the sum of the semidiameters of the moon and earth's shadow, denotes the instant when the eclipse begins, namely, at 52 minutes after eight; the point T, where the moon's path intersects on the right hand the arch described, with the difference of the semidiameters, denotes the instant when the moon's total darkness begins, namely, at 48 minutes after nine; the point F denotes the middle of the eclipse at 39 minutes after 10; the point S, where the moon's path intersects on the left hand the arch described, with the difference of the semidiameters, denotes the end of the moon's total darkness at 30 minutes after eleven; and the point R, where the moon's path intersects the arch described, with the sum of the semidiameters, denotes the end of the eclipse at 26 minutes after 12, all mean time according to the meridian of Greenwich. If the times reckoned by any other meridian are required, apply the longitude from Greenwich to the Greenwich times, by addition or subtraction, according as the place is east or west of Greenwich.

On F as a centre, with a radius equal to the moon's semidiameter, describe a circle which represents the moon's disk at the middle of the eclipse.

The line VX denotes the quantity eclipsed at the middle of the eclipse, which may be measured on a line equal to the moon's diameter, and divided into equal parts for digits. In the present case, the eclipse being total, the quantity eclipsed is said to be greater than the moon's diameter, and is found to be $21\frac{1}{2}$ digits.

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CHAP. III.

CATALOGUE OF FIXED STARS, AND TABLES OF REDUCTION.

SECT. I.—Right Ascensions and North Polar Distances of Five Hundred and Twenty-nine Stars, not less than the 4.5 Magnitude.

From Observations made at the Royal Observatory at Greenwich.

Reduced to January 1, 1830.

STARS.	Mag.	R. A.	Annual Precession.	N. P. D.	Annual Precession.	STARS.	Mag.	R. A.	Annual Precession.	N. P. D.	Annual Precession.
		H. M. S.	S.	° ' "	"			H. M. S.	S.	° ' "	"
β Cassiopeæ.....	2.3	0 0 9.47	+ 3.12	31 47 17.8	— 20.0	α PERSEI.....	2.3	3 12 13.70	+ 4.22	40 45 5.1	— 13.4
γ PEGASUS.....	2.3	0 4 29.55	+ 3.08	75 45 41.8	— 20.0	Camelopardali	4	3 15 21.96	+ 4.77	30 39 40.5	— 13.2
ι Ceti.....	4	0 10 46.03	+ 3.06	99 45 58.7	— 20.0	ο Tauri.....	4.5	3 15 40.56	+ 3.22	81 34 29.4	— 13.2
κ Cassiopeæ.....	4	0 23 24.15	+ 3.32	28 0 27.8	— 19.9	Camelopardali	4.5	3 16 24.11	+ 4.70	31 43 11.6	— 31.1
ζ.....	4	0 27 32.62	+ 3.28	37 2 22.8	— 19.9	ξ Tauri.....	4	3 17 58.05	+ 3.23	80 51 54.5	— 13.0
π Andromedæ.....	4.5	0 27 49.37	+ 3.17	57 13 2.4	— 19.9	17 Eridani.....	4.5	3 22 11.37	+ 2.97	95 39 47.6	— 12.7
σ.....	4	0 29 35.49	+ 3.16	61 36 43.0	— 19.9	ι.....	4	3 24 55.73	+ 2.88	100 2 18.7	— 12.6
δ.....	3	0 30 15.47	+ 3.17	60 4 11.6	— 19.9	19.....	4	3 26 16.98	+ 2.64	112 12 26.3	— 12.5
α CASSIOPEÆ.....	3	0 30 54.60	+ 3.33	34 23 46.8	— 19.9	δ Persei.....	3.4	3 30 51.40	+ 4.22	42 45 50.6	— 12.1
β Ceti.....	2.3	0 35 3.27	+ 3.00	108 55 12.2	— 19.8	ν.....	4.5	3 33 40.35	+ 4.04	47 57 58.3	— 11.9
ζ Andromedæ.....	4	0 38 20.69	+ 3.16	66 39 31.4	— 19.8	.....	4	3 33 .....	.....	58 15	— 11.9
η Cassiopeæ.....	4	0 38 52.10	+ 3.53	33 5 19.7	— 19.0	b Pleiad. Elec...	4.5	3 34 47.67	+ 3.54	66 25 39.3	— 11.9
ν Andromedæ.....	4	0 40 28.30	+ 3.27	49 50 53.7	— 19.7	δ Eridani.....	3.4	3 35 6.52	+ 2.87	100 20 40.0	— 11.2
γ Cassiopeæ.....	3	0 46 30.77	+ 3.53	30 12 21.2	— 19.6	η Tauri.....	3	3 37 23.57	+ 3.54	66 25 37.7	— 11.7
μ Andromedæ.....	4	0 47 20.76	+ 3.36	52 25 27.7	— 19.6	ζ Persei.....	3.4	3 43 27.87	+ 3.74	58 37 40.9	— 11.2
ι Piscium.....	4	0 54 7.74	+ 3.11	83 1 35.5	— 19.5	.....	3.4	3 46 28.20	+ 3.99	50 29 21.9	— 11.0
POLARIS.....	2.3	0 59 32.00	+ 15.52	1 35 51.4	— 19.4	1 γ Eridani.....	2.3	3 50 6.15	+ 2.79	103 59 50.1	— 10.8
η Ceti.....	3.4	1 0 2.46	+ 3.00	101 5 6.2	— 19.4	λ Tauri.....	4	3 51 16.26	+ 3.31	77 59 46.1	— 10.7
β Andromedæ.....	2	1 0 14.34	+ 3.31	55 16 57.4	— 19.4	1 λ Persei.....	4	3 53 57.21	+ 4.44	40 7 8.2	— 10.5
θ Cassiopeæ.....	4.5	1 0 48.07	+ 3.56	35 45 24.8	— 19.3	μ.....	4.5	4 2 26.73	+ 4.36	42 1 53.8	— 9.8
↓.....	4.5	1 14 2.29	+ 4.08	22 45 39.3	— 19.0	ο Eridani.....	4.5	4 3 34.35	+ 2.92	97 17 12.4	— 9.8
.....	3	1 14 45.78	+ 3.83	30 39 6.6	— 19.0	γ Tauri.....	3.4	4 10 7.64	+ 3.39	74 47 22.1	— 9.2
1 θ Ceti.....	3	1 15 31.68	+ 3.00	99 3 45.0	— 19.0	41 Eridani.....	3.4	4 11 27.90	+ 2.26	124 13 13.1	— 9.1
ι Piscium.....	4	1 22 23.97	+ 3.19	75 31 58.1	— 18.8	1 δ } Tauri.....	4	4 13 8.43	+ 3.44	72 51 47.3	— 9.0
51 Andromedæ.....	3.4	1 27 36.04	+ 3.62	42 14 11.2	— 18.6	2 δ } Tauri.....	4.5	4 14 18.27	+ 3.44	72 57 24.7	— 8.9
τ Ceti.....	3.4	1 36 10.45	+ 2.78	106 50 5.7	— 19.1	43 Eridani.....	4.5	4 17 .....	.....	124 25 5.8	— 8.7
ι Cassiopeæ.....	3.4	1 42 15.11	+ 4.19	27 10 19.7	— 18.1	ς Tauri.....	4	4 18 41.97	+ 3.48	71 12 13.6	— 8.6
ζ Ceti.....	3	1 43 4.45	+ 2.95	101 10 40.7	— 18.1	ALDEBARAN.....	1	4 26 10.50	+ 3.43	73 50 22.7	— 8.0
α Trianguli.....	3.4	1 43 24.74	+ 3.39	61 15 9.0	— 18.0	2 ν Eridani.....	4	4 27 49.73	+ 2.99	93 42 22.6	— 7.8
2 γ Arietis.....	4.5	1 44 13.06	+ 3.26	71 32 35.8	— 18.0	53.....	4	4 30 24.03	+ 2.75	104 38 29.8	— 7.6
β.....	3	1 45 15.99	+ 3.28	70 1 34.9	— 18.0	54.....	4	4 33 0.62	+ 2.62	110 0 11.4	— 7.4
50 Cassiopeæ.....	4.5	1 49 5.64	+ 4.91	18 24 24.7	— 17.8	Camelopardali	4.5	4 37 12.41	+ 5.88	23 57 35.9	— 7.1
2 ν Ceti.....	4.5	1 51 59.72	+ 2.82	111 54 25.0	— 17.7	1 Orionis.....	4	4 40 37.16	+ 3.25	83 20 33.1	— 6.8
γ Andromedæ.....	3.4	1 53 29.84	+ 3.63	48 29 24.4	— 17.6	3.....	4	4 42 9.59	+ 3.19	84 41 32.5	— 6.7
α ARIETIS.....	3	1 57 36.49	+ 3.34	67 20 42.7	— 17.5	8.....	4.5	4 45 24.15	+ 3.12	87 50 40.7	— 6.4
β Trianguli.....	4	1 59 27.30	+ 3.52	55 49 15.9	— 17.4	Aurigæ.....	4	4 45 56.10	+ 3.89	57 6	— 6.4
Cass. 35 Hev.	4.5	2 15 10.64	+ 4.79	23 22 7.1	— 16.7	10 Camelopardali	4.5	4 48 19.87	+ 5.29	29 49 8.3	— 6.2
ν Ceti.....	4.5	2 26 57.74	+ 3.14	85 9 9.2	— 16.1	ς Aurigæ.....	4	4 49 47.20	+ 4.28	46 26 16.8	— 6.0
δ.....	4	2 30 46.69	+ 3.06	90 24 32.4	— 15.9	ζ.....	4	4 50 36.70	+ 4.17	49 10 55.4	— 6.0
ι.....	4.5	2 31 20.81	+ 2.89	102 35 41.4	— 15.8	ι Tauri.....	4.5	4 52 56.62	+ 3.57	68 39 38.3	— 5.8
θ Persei.....	4	2 32 37.76	+ 4.05	41 29 47.7	— 15.8	η Aurigæ.....	4	4 54 36.39	+ 4.18	49 0 18.3	— 5.6
35 Arietis.....	4	2 33 29.77	+ 3.49	63 1 16.9	— 15.7	105 Tauri.....	4	4 57 45.97	+ 3.57	68 31 41.2	— 5.4
γ Ceti.....	3	2 34 30.04	+ 3.11	87 29 5.8	— 15.7	ς Leporis.....	4	4 58 16.21	+ 2.53	112 36 18.2	— 5.3
μ.....	4	2 35 45.81	+ 3.21	80 36 28.8	— 15.6	β Eridani.....	3	4 59 30.11	+ 2.95	95 18 45.3	— 5.2
π.....	4	2 36 2.09	+ 2.85	104 34 57.7	— 15.6	λ.....	4	5 1 0.94	+ 2.86	98 58 40.5	— 5.1
39 Arietis.....	4	2 37 48.28	+ 3.53	61 27 51.5	— 15.5	CAPELLA.....	1	5 4 8.61	+ 4.41	44 11 5.1	— 4.8
16 Persei.....	4.5	2 39 52.85	+ 3.73	52 23 13.2	— 15.4	ς Leporis.....	4.5	5 4 22.23	+ 2.79	102 4 46.4	— 4.8
41 Arietis.....	3	2 39 59.76	+ 3.50	63 26 43.2	— 15.4	Orionis.....	4	5 5 23.18	+ 2.88	98 21 15.3	— 4.7
2 τ Eridani.....	4.5	2 43 19.97	+ 2.72	111 42 29.4	— 15.2	RIGEL.....	1	5 6 22.29	+ 2.88	98 24 15.2	— 4.6
η.....	3	2 48 7.73	+ 2.92	99 34 44.1	— 14.9	τ Orionis.....	4	5 9 21.30	+ 2.91	97 2 4.7	— 4.4
γ Persei.....	4	2 52 32.06	+ 4.27	37 9 59.7	— 14.6	λ Leporis.....	4.5	5 11 44.82	+ 2.76	103 21 29.6	— 4.2
α CETI.....	2.3	2 53 24.08	+ 3.12	86 34 55.5	— 14.6	β TAURI.....	3	5 15 33.14	+ 3.78	61 32 40.2	— 3.9
ρ Persei.....	4	2 54 18.69	+ 3.79	51 49 28.4	— 14.5	η Orionis.....	4.5	5 15 56.01	+ 3.01	92 33 36.9	— 3.8
11 Eridani.....	4	2 54 .....	.....	114 17 41.3	— 14.5	γ ORIONIS.....	2	5 16 1.00	+ 3.20	83 48 40.5	— 3.8
Persei.....	4	2 56 50.48	+ 4.14	41 2 36.4	— 14.4	β Leporis.....	4	5 20 57.86	+ 2.57	110 54 1.2	— 3.4
β.....	2.3	2 57 8.25	+ 3.86	49 42 20.8	— 14.3	δ ORIONIS.....	2	5 23 19.57	+ 3.06	90 25 54.9	— 3.2
δ Arietis.....	4	3 1 55.29	+ 3.40	70 55 18.5	— 14.1	ς Columbæ.....	4	5 25 10.76	+ 2.12	125 36 16.6	— 3.0
12 Eridani.....	3.4	3 4 51.29	+ 2.56	119 39 40.8	— 14.7	α Leporis.....	3.4	5 25 14.17	+ 2.64	107 56 57.7	— 3.0
ζ.....	4	3 7 34.85	+ 2.91	99 27 21.2	— 13.7	1 φ Orionis.....	4.5	5 25 29.46	+ 3.29	80 38	— 3.0
16.....	3.4	3 11 57.63	+ 2.66	112 22 51.7	— 13.4	λ.....	4	5 25 46.81	+ 3.30	80 11 13.2	— 3.0

RIGHT ASCENSIONS AND NORTH POLAR DISTANCES OF 529 STARS.

STARS.	Mag.	R. A.	Annual Precession.	N. P. D.	Annual Precession.	STARS.	Mag.	R. A.	Annual Precession.	N. P. D.	Annual Precession.
	S.	H. M. S.	S.	° ' "	"		S.	H. M. S.	S.	° ' "	"
Orionis.....	3.4	5 27 7.29	+ 2.93	96 1 41.1	— 2.9	λ Leonis.....	4.5	9 22 0.57	+ 3.44	66 17 12.8	+ 15.5
ζ Tauri.....	3.4	5 27 29.35	+ 3.58	68 58 8.3	— 2.8	ο.....	4	9 32 4.29	+ 3.22	79 20 17.0	+ 16.0
ORIONIS.....	2	5 27 35.44	+ 3.03	91 19 2.2	— 2.8	ε.....	3	9 36 11.35	+ 3.43	65 26 49.1	+ 16.2
σ.....	4	5 30 12.93	+ 3.01	92 42 17.4	— 2.6	υ Ursæ Majoris	4.5	9 38 49.74	+ 4.36	30 10 0.8	+ 16.4
ζ.....	3	5 32 11.07	+ 3.01	92 2 21.2	— 2.4	μ Leonis.....	3	9 43 4.87	+ 3.45	63 11 47.4	+ 16.6
α Columbae.....	2	5 33 29.83	+ 2.17	124 10 19.0	— 2.3	π.....	4.5	9 51 13.54	+ 3.18	81 8 36.2	+ 17.0
γ Leporis.....	4	5 37 22.75	+ 2.52	112 30 32.6	— 2.0	η.....	3.4	9 58 3.37	+ 3.28	72 24 41.8	+ 17.3
ζ.....	4.5	5 39 15.42	+ 2.71	104 53 28.6	— 1.8	REGULUS.....	1	9 59 18.72	+ 3.21	77 12 16.7	+ 17.3
α Orionis.....	3	5 39 41.72	+ 2.84	99 44 10.4	— 1.8	2 λ Hydrae.....	4.5	10 2 18.27	+ 2.93	101 31 0.1	+ 17.5
136 Tauri.....	4.5	5 42 38.79	+ 3.76	62 26 10.7	— 1.5	λ Ursæ Majoris	3.4	10 6 48.76	+ 3.68	46 14 25.0	+ 17.6
β Columbae.....	3	5 44 58.10	+ 2.11	125 50 27.0	— 1.3	ζ Leonis.....	4.5	10 7 13.32	+ 3.35	65 44 22.4	+ 17.7
δ Aurigæ.....	3.4	5 45 31.98	+ 4.92	35 44 23.5	— 1.3	γ LEONIS.....	2	10 10 35.36	+ 3.30	69 18 5.2	+ 17.8
α ORIONIS.....	1	5 45 58.29	+ 3.25	82 37 54.8	— 1.2	μ Ursæ Majoris	3	10 12 10.29	+ 3.62	47 38 56.5	+ 17.9
β AURIGÆ.....	2	5 47 3.62	+ 4.39	45 4 47.2	— 1.1	30 Leonis Min...	4.5	10 16 8.97	+ 3.47	55 20 27.2	+ 18.0
θ.....	4	5 48 7.76	+ 4.08	52 48 30.6	— 1.0	μ Hydrae.....	4	10 17 52.51	+ 2.90	105 58 14.0	+ 18.1
η Leporis.....	4	5 48 39.94	+ 2.73	104 12 17.1	— 1.0	31 Leonis Min...	4.5	10 18 1.80	+ 3.51	52 25 27.8	+ 18.1
γ Columbae.....	4	5 51 30.62	+ 2.12	125 18 33.3	— 0.7	α Antl. Pneu....	4.5	10 19 23.00	+ 2.74	120 12 14.3	+ 18.1
υ Orionis.....	4.5	5 57 52.01	+ 3.42	75 13 6.5	— 0.2	ε Leonis.....	4	10 23 51.27	+ 3.17	79 49 15.0	+ 18.3
θ Leporis.....	4.5	5 58 27.82	+ 2.71	104 55 33.6	— 0.1	37 Leonis Min...	4	10 29 8.06	+ 3.40	57 8 35.2	+ 18.5
α Aurigæ.....	4	6 4 32.78	+ 3.83	60 26 51.9	+ 0.4	42.....	4.5	10 36 23.65	+ 3.36	58 25 28.2	+ 18.7
η Geminorum...	4.5	6 4 37.00	+ 3.62	67 27 7.7	+ 0.4	υ Hydr. & Crat.	4	10 41 14.59	+ 2.95	105 18 20.7	+ 18.9
2 Lynceis.....	4.5	6 4 36.91	+ 5.30	30 56 25.4	+ 0.4	ο Leonis Min...	4.5	10 43 46.84	+ 3.38	54 52 14.3	+ 18.9
5 Monocerotis..	4.5	6 6 33.95	+ 2.92	96 13 45.5	+ 0.6	54 Leonis.....	4.5	10 46 23.82	+ 3.27	64 20 43.6	+ 19.0
α Columbae.....	4.5	6 10 30.48	+ 2.13	125 5 29.6	+ 0.9	α Hydr. & Crat.	4	10 51 30.01	+ 2.91	107 23 40.7	+ 19.2
μ Geminorum...	3	6 12 40.59	+ 3.62	67 24 26.5	+ 1.1	β Ursæ Majoris	2	10 51 31.67	+ 3.68	32 42 30.0	+ 19.2
ζ Canis Majoris	3	6 13 47.41	+ 2.30	119 59 34.1	+ 1.2	α URSAE MAJ...	1.2	10 53 9.86	+ 3.80	27 19 58.4	+ 19.2
β.....	2.3	6 15 12.93	+ 2.64	107 52 36.9	+ 1.3	χ Leonis.....	4.5	10 56 14.77	+ 3.09	81 44 47.6	+ 19.3
λ.....	4	6 15 54.19	+ 2.19	123 21 25.7	+ 1.4	ψ Ursæ Majoris	3.4	11 0 4.56	+ 3.42	44 34 50.3	+ 19.4
γ Geminorum...	3	6 27 53.37	+ 3.46	73 27 47.8	+ 2.4	φ Hydr. & Crat.	4	11 3 18.52	+ 2.94	111 53 54.1	+ 19.4
ε.....	3	6 33 28.25	+ 3.69	64 42 32.3	+ 2.9	δ LEONIS.....	3	11 5 3.60	+ 3.19	68 32 44.9	+ 19.5
2 ξ.....	4	6 35 44.77	+ 3.38	76 55 41.9	+ 3.1	θ.....	3	11 5 18.82	+ 3.16	73 38 32.0	+ 19.5
SIRIUS.....	1	6 37 39.27	+ 2.64	106 29 20.1	+ 4.4	ξ Ursæ Majoris	4	11 9 5.99	+ 3.22	57 30 55.3	+ 20.2
2 α Canis Majoris	4	6 43 29.65	+ 2.24	122 19 3.9	+ 3.8	υ.....	4	11 9 16.68	+ 3.27	55 58 43.8	+ 19.6
1. ο.....	4	6 47 4.94	+ 2.49	113 58 35.9	+ 4.1	δ Hydr. & Crat.	3.4	11 10 50.87	+ 3.00	103 51 33.2	+ 19.6
ι.....	4.5	6 48 33.42	+ 2.67	106 50 21.9	+ 4.2	σ Leonis.....	4	11 12 22.16	+ 3.10	83 2 24.2	+ 19.6
κ.....	2.3	6 51 56.89	+ 2.35	118 44 43.5	+ 4.5	ι.....	4	11 15 3.48	+ 3.12	78 32 6.4	+ 19.7
ζ Geminorum...	4	6 54 1.30	+ 3.56	69 11 17.0	+ 4.7	γ Hydr. & Crat.	4	11 16 23.79	+ 2.99	106 45 2.2	+ 19.7
Camelopardali	4.5	6 54 48.83	+ 13.22	7 17 22.7	+ 4.7	τ Leonis.....	4	11 19 11.76	+ 3.08	86 12 29.2	+ 19.7
σ Canis Majoris	3.4	6 54 57.03	+ 2.39	117 41 45.0	+ 4.8	λ Draconis.....	3.4	11 21 12.88	+ 3.70	19 43 55.8	+ 19.8
2 ο.....	4	6 55 55.79	+ 2.50	113 35 25.8	+ 4.8	87 Leonis.....	4.5	11 21 37.91	+ 3.06	92 3 57.9	+ 19.8
γ.....	4	6 56 4.04	+ 2.71	105 23 16.7	+ 4.9	ξ Hydr. & Crat.	4	11 24 39.51	+ 2.95	120 55 1.9	+ 19.8
δ.....	3.4	7 1 28.81	+ 2.44	116 7 41.3	+ 5.3	θ.....	4	11 28 3.92	+ 3.04	98 51 44.3	+ 19.8
22 Monocerotis..	4.5	7 3 10.96	+ 3.06	90 13 4.1	+ 5.5	υ Leonis.....	4.5	11 28 14.98	+ 3.07	89 53 8.1	+ 19.9
27 Canis Majoris	4.5	7 7 19.63	+ 2.44	116 3 51.4	+ 5.8	ζ Hydr. & Crat.	4	11 36 9.43	+ 3.03	107 24 18.9	+ 19.9
λ Geminorum...	4.5	7 8 19.06	+ 3.46	73 9 36.7	+ 5.9	χ Ursæ Majoris	4	11 37 2.56	+ 3.22	41 16 41.3	+ 19.9
δ.....	3.4	7 9 57.93	+ 3.59	67 42 44.3	+ 6.0	υ Virginis.....	4.5	11 37 7.25	+ 3.09	82 31 4.8	+ 19.9
ι.....	4	7 15 9.56	+ 3.74	61 52 19.0	+ 6.5	93 Leonis.....	4	11 39 12.56	+ 3.12	68 50 11.1	+ 20.0
η Canis Majoris	3	7 17 22.48	+ 2.37	118 58 34.4	+ 6.6	β LEONIS.....	2.3	11 40 23.04	+ 3.07	74 28 39.3	+ 20.0
β Canis Minoris	3	7 17 55.69	+ 3.26	81 22 29.6	+ 6.7	β Virginis.....	3.4	11 41 50.66	+ 3.12	87 16 38.3	+ 20.0
CASTOR.....	3	7 23 44.48	+ 3.85	57 44 49.0	+ 7.2	β Hydrae.....	4	11 44 20.40	+ 3.01	122 57 48.1	+ 20.0
PROCYON.....	1.2	7 30 24.05	+ 3.15	84 20 44.2	+ 8.7	γ URSAE MAJ...	2	11 44 51.00	+ 3.21	35 21 35.0	+ 20.0
26 Monocerotis..	4.5	7 33 7.56	+ 2.87	99 9 37.2	+ 7.9	ο Virginis.....	4.5	11 56 32.88	+ 3.07	80 19 19.2	+ 20.0
α Geminorum...	4	7 34 10.53	+ 3.64	65 12 5.6	+ 8.0	α Corvi.....	4.5	11 59 39.65	+ 3.07	113 46 46.0	+ 20.0
POLLUX.....	2	7 34 54.22	+ 3.69	61 34 13.2	+ 8.1	ε.....	4	12 1 23.75	+ 3.07	111 40 22.1	+ 20.0
ξ Argus.....	4	7 42 8.86	+ 2.52	114 26 16.2	+ 8.6	δ URSAE MAJ...	3	12 6 58.38	+ 3.00	32 1 19.7	+ 20.0
15.....	3.4	8 0 18.43	+ 2.56	113 49 7.9	+ 10.0	γ Corvi.....	3	12 7 4.53	+ 3.08	106 35 48.1	+ 20.0
β Cancræ.....	4	8 7 17.48	+ 3.26	80 17 46.9	+ 10.6	η Virginis.....	3.4	12 11 12.55	+ 3.07	89 43 15.5	+ 20.0
ο Ursæ Majoris	4.5	8 16 4.20	+ 5.09	28 43 21.9	+ 11.2	16 Comæ Beren.	4.5	12 18 28.80	+ 3.01	62 13 53.7	+ 20.0
δ Hydrae.....	4	8 28 39.10	+ 3.19	83 42 31.5	+ 12.1	δ Corvi.....	3	12 21 4.86	+ 3.10	105 34 3.1	+ 20.0
δ Cancræ.....	4.5	8 35 0.94	+ 3.42	71 13 34.7	+ 12.5	η.....	4.5	12 23 19.23	+ 3.11	105 15 10.4	+ 19.9
α Pixidis Naut.	4.5	8 36 46.10	+ 2.41	122 34 42.2	+ 12.7	β.....	2.3	12 25 28.40	+ 3.13	112 27 15.8	+ 19.9
ε Hydrae.....	4	8 37 46.16	+ 3.20	82 57 45.9	+ 12.7	8 Canum Ven...	4.5	12 25 39.18	+ 2.86	47 43 3.1	+ 19.9
ζ.....	4	8 46 24.16	+ 3.18	83 24 44.7	+ 13.3	α Draconis.....	3.4	12 26 10.64	+ 2.60	19 16 24.3	+ 19.9
1. υ Ursæ Majoris	3.4	8 47 31.81	+ 4.13	41 17 49.0	+ 13.4	23 Comæ Beren.	4.5	12 26 22.73	+ 3.00	66 26 0.0	+ 19.9
κ.....	4.5	8 51 58.89	+ 4.15	42 10 40.3	+ 13.7	1. γ Virginis.....	4	12 33 3.09	+ 3.02	90 30 55.2	+ 19.8
θ Hydrae.....	4.5	9 5 30.95	+ 3.12	86 58 22.1	+ 14.5	ε Ursæ Majoris	3	12 46 31.60	+ 2.66	33 6 56.8	+ 19.6
38 Lynceis.....	4	9 8 14.53	+ 3.77	52 29 0.1	+ 14.7	δ Virginis.....	3.4	12 47 2.59	+ 3.00	85 40 35.5	+ 19.6
40.....	4.5	9 10 40.73	+ 3.70	54 53 37.9	+ 14.8	α Canum Ven...	2.3	12 48 3.90	+ 2.84	50 45 42.5	+ 19.6
α HYDRAE.....	2	9 19 14.07	+ 2.95	97 55 30.9	+ 15.3	36 Comæ Beren.	4.5	12 50 30.83	+ 2.97	71 40 18.9	+ 19.6
υ Ursæ Majoris	3	9 21 26.46	+ 4.06	37 33 11.8	+ 16.0	ε Virginis.....	3.4	12 53 43.01	+ 3.00	78 7 28.8	+ 19.5

RIGHT ASCENSIONS AND NORTH POLAR DISTANCES OF 529 STARS.

STARS.	Mag.	R. A.	Annual Precession.	N. P. D.	Annual Precession.	STARS.	Mag.	R. A.	Annual Precession.	N. P. D.	Annual Precession.
	S.	H. M. S.	S.	° ' "	"		S.	H. M. S.	S.	° ' "	"
41 Comæ Beren.	4	12 59 1.07	+ 2.88	61 27 37.4	+ 19.4	ζ Ursæ Minoris	4	15 50 18.68	- 2.38	11 41 12.6	+ 10.7
ψ Hydræ.....	4.5	12 59 54.95	+ 3.21	112 12 20.1	+ 19.4	ε Coronæ Bor...	4.5	15 50 33.22	+ 2.48	62 37 28.9	+ 10.7
δ Virginis.....	4.5	13 1 9.47	+ 3.10	94 37 43.8	+ 19.3	π Serpentis.....	4.5	15 54 58.76	+ 2.58	66 43 5.2	+ 10.4
υ Comæ Beren..	4.5	13 1 43.05	+ 2.95	71 34 8.4	+ 19.3	ξ Libræ.....	4.5	15 55 1.75	+ 3.29	100 53 49.2	+ 10.4
61 Virginis.....	4.5	13 9 31.93	+ 3.11	107 21 44.7	+ 20.2	θ Lupi.....	4	15 55 ...	+ 3.91	126 19 ...	+ 10.4
γ Hydræ.....	4.5	13 9 41.99	+ 3.23	112 16 16.3	+ 19.1	1) β Scorpii.....	2	15 55 33.96	+ 3.47	109 19 54.6	+ 10.4
ι Centauri.....	3	13 11 4.24	+ 3.36	125 48 57.4	+ 19.1	2) ...	5.6	15 55 34.57	...	109 19 ...	+ 10.4
SPICA VIRG...	1	13 16 14.86	+ 3.14	100 16 14.3	+ 18.9	1) ω.....	4.5	15 56 52.70	+ 3.49	110 12 2.5	+ 10.3
ζ URSE MAJ...	3	13 17 3.80	+ 2.41	34 11 4.0	+ 18.9	2) ...	4.5	15 57 27.04	+ 3.50	110 24 3.9	+ 10.2
ζ Virginis.....	4	13 26 2.32	+ 3.07	89 43 24.1	+ 18.6	θ Draconis.....	3.4	15 58 ...	+ 1.15	30 58 43.5	+ 10.1
η URSE MAJ...	2.3	13 40 49.97	+ 2.37	39 50 7.2	+ 18.1	υ Scorpii.....	4	16 2 7.72	+ 3.47	109 0 36.9	+ 9.9
υ Bootis.....	4	13 41 16.66	+ 2.90	73 21 18.5	+ 18.1	δ OPHIUCHI.....	3	16 5 26.69	+ 3.13	93 14 57.4	+ 9.6
3 Centauri.....	4.5	13 42 2.52	+ 3.43	122 8 48.5	+ 18.1	ε.....	3	16 9 20.00	+ 3.16	94 16 15.3	+ 9.3
10 Draconis.....	4.5	13 46 27.86	+ 1.75	24 26 5.1	+ 17.9	σ Scorpii.....	4	16 10 52.16	+ 3.63	115 10 33.6	+ 9.2
η Bootis.....	3	13 46 35.63	+ 2.86	70 44 46.9	+ 17.9	γ Herculis.....	3.4	16 14 25.43	+ 2.64	70 26 30.0	+ 8.9
τ Virginis.....	4.5	13 53 0.10	+ 3.04	87 37 43.3	+ 17.7	τ.....	4	16 14 38.13	+ 1.80	43 16 40.4	+ 8.9
σ Hydræ.....	4.5	13 56 42.79	+ 3.38	115 51 27.9	+ 17.5	ANTARES.....	1	16 18 59.77	+ 3.66	116 2 43.5	+ 8.6
θ Centauri.....	2	13 56 42.49	+ 3.49	125 31 56.5	+ 17.5	φ Ophiuchi.....	4.5	16 21 25.10	+ 3.42	106 14 1.2	+ 8.4
α DRACONIS.....	3.4	13 59 47.48	+ 1.62	24 48 34.2	+ 17.4	η Draconis.....	3	16 21 42.11	+ 0.79	28 5 57.6	+ 8.3
κ Virginis.....	4	14 3 50.43	+ 3.18	99 28 39.5	+ 17.2	λ Ophiuchi.....	4	16 22 20.91	+ 3.02	87 38 11.2	+ 8.3
ι.....	4	14 7 6.72	+ 3.13	95 11 5.0	+ 17.0	β Herculis.....	2.3	16 22 54.95	+ 2.58	68 8 2.8	+ 8.2
ARCTURUS...	1	14 7 54.64	+ 2.73	69 55 42.6	+ 19.0	29.....	4.5	16 24 39.23	+ 2.81	78 8 24.4	+ 8.1
λ Bootis.....	4	14 9 54.97	+ 2.27	43 7 40.3	+ 16.9	τ Scorpii.....	3.4	16 25 18.87	+ 3.72	117 51 14.1	+ 8.0
λ Virginis.....	4	14 9 55.77	+ 3.23	102 35 0.9	+ 16.9	ζ Ophiuchi.....	3.4	16 27 48.44	+ 3.29	100 12 54.1	+ 7.8
ι Bootis.....	4.5	14 10 8.44	+ 2.14	37 50 44.2	+ 16.9	15 Draconis.....	4.5	16 28 21.12	- 0.16	20 51 51.8	+ 7.8
θ.....	4	14 19 24.48	+ 2.02	37 21 37.6	+ 17.0	σ Herculis.....	4	16 28 37.64	+ 1.93	47 12 28.9	+ 7.8
ε.....	4	14 24 30.16	+ 2.59	58 52 41.3	+ 16.2	ζ.....	3	16 34 52.83	+ 2.25	58 5 3.7	+ 7.3
γ.....	3.4	14 25 13.86	+ 2.43	50 56 39.7	+ 16.2	η.....	3	16 37 4.30	+ 2.05	50 45 0.4	+ 7.1
5 Ursæ Minoris	4	14 27 59.32	- 0.27	13 32 54.0	+ 16.0	ι Scorpii.....	3	16 39 10.80	+ 3.87	123 58 35.9	+ 6.9
π Bootis.....	3.4	14 32 44.32	+ 2.81	72 50 52.8	+ 15.8	ι Ophiuchi.....	4	16 45 58.03	+ 2.83	79 32 52.1	+ 6.4
ζ.....	3.4	14 33 2.02	+ 2.86	75 32 15.7	+ 15.7	κ.....	4	16 49 37.66	+ 2.85	80 21 17.9	+ 6.1
μ Virginis.....	4.5	14 34 6.74	+ 3.14	94 54 49.7	+ 15.7	ι Herculis.....	3	16 53 47.33	+ 2.29	58 49 4.2	+ 5.7
34 Bootis.....	4.5	14 35 57.13	+ 2.64	62 44 42.3	+ 15.6	η Ophiuchi.....	2.3	17 0 38.29	+ 3.43	105 30 21.3	+ 5.1
35.....	4.5	14 37 18.73	+ 2.80	72 18 39.9	+ 15.5	μ Draconis.....	4	17 1 49.10	+ 1.24	35 18 12.0	+ 5.0
ι Bootis.....	3	14 37 33.75	+ 2.61	62 12 16.4	+ 15.5	ι Ursæ Minoris	4	17 3 40.59	- 6.58	7 41 49.2	+ 4.9
109 Virginis.....	4	14 37 39.71	+ 3.03	87 23 9.7	+ 15.5	36 Ophiuchi.....	4.5	17 4 54.30	+ 3.67	116 20 35.3	+ 6.0
1) α LIBRÆ.....	6	14 41 17.87	+ 3.29	105 17 3.4	+ 15.3	α HERCULIS.....	3.4	17 6 53.98	+ 2.73	75 24 32.7	+ 4.6
2) ...	3	14 41 29.34	+ 3.29	105 19 45.5	+ 15.3	ο Ophiuchi.....	4.5	17 7 52.85	+ 3.07	90 14 46.3	+ 4.5
ξ Bootis.....	3.4	14 43 33.09	+ 2.75	70 11 22.7	+ 15.2	δ Herculis.....	4	17 8 3.15	+ 2.46	64 57 16.4	+ 4.5
β URSE MIN...	3	14 51 17.35	- 0.31	15 8 58.5	+ 14.7	ζ Draconis.....	3	17 8 19.10	+ 0.15	24 4 32.7	+ 4.5
δ Libræ.....	4.5	14 51 54.09	+ 3.19	97 50 19.4	+ 14.7	π Herculis.....	3.4	17 9 7.88	+ 2.09	52 59 40.0	+ 4.4
20.....	3.4	14 54 8.50	+ 3.49	114 36 24.6	+ 14.5	ρ Ophiuchi.....	4.5	17 10 49.25	+ 3.57	110 55 17.3	+ 4.3
β Bootis.....	3	14 55 32.59	+ 2.26	48 56 5.5	+ 14.4	68 Herculis.....	4	17 11 3.03	+ 2.21	56 42 40.7	+ 4.2
2 Lupi.....	4.5	15 7 30.70	+ 3.62	119 30 56.6	+ 13.7	υ Serpentis.....	4.5	17 11 16.38	+ 3.36	102 39 58.4	+ 4.2
β Libræ.....	2.3	15 7 52.27	+ 3.22	98 44 57.6	+ 13.7	θ Ophiuchi.....	3.4	17 11 34.74	+ 3.67	114 49 12.9	+ 4.2
δ Bootis.....	3.4	15 8 39.08	+ 2.41	56 2 46.0	+ 13.6	69 Herculis.....	4.5	17 11 48.82	+ 2.07	52 31 31.6	+ 4.2
μ.....	4	15 18 4.22	+ 2.28	52 1 20.1	+ 13.0	ρ Herculis.....	4	17 17 49.36	+ 2.07	52 41 33.4	+ 3.7
β Coronæ Bor..	4	15 20 49.38	+ 2.48	60 18 11.8	+ 12.8	σ Ophiuchi.....	4.5	17 18 5.16	+ 2.97	85 42 16.8	+ 3.6
2 γ URSE MINORIS	3.4	15 21 4.17	- 0.18	17 33 39.3	+ 12.8	υ Scorpii.....	3.4	17 19 ...	+ 4.06	127 9 ...	+ 3.5
ι Draconis.....	3	15 21 9.44	+ 1.32	30 26 9.5	+ 12.8	λ Scorpii.....	3	17 22 4.53	+ 4.06	126 58 30.7	+ 3.3
37 Libræ.....	4	15 24 53.89	+ 3.24	99 28 29.2	+ 12.6	λ Herculis.....	4.5	17 23 52.28	+ 2.42	63 45 18.9	+ 3.1
γ.....	4.5	15 26 1.80	+ 3.33	104 12 54.9	+ 12.5	β DRACONIS.....	2	17 26 35.76	+ 1.34	37 34 10.3	+ 2.9
θ Coronæ Bor..	4.5	15 26 4.64	+ 2.42	58 3 43.3	+ 12.5	α OPHIUCHI.....	2	17 27 2.85	+ 2.77	77 18 32.6	+ 2.9
δ Serpentis.....	3	15 26 41.32	+ 2.86	78 53 13.9	+ 12.4	ο Serpentis.....	4.5	17 31 51.90	+ 3.37	102 46 33.5	+ 2.5
α COR. BOR.....	2	15 27 29.59	+ 2.53	62 42 28.5	+ 12.4	ι Herculis.....	4	17 34 40.21	+ 1.69	43 53 57.4	+ 2.2
40 Libræ.....	4.5	15 28 14.36	+ 3.66	119 12 37.5	+ 12.3	β Ophiuchi.....	3	17 35 4.74	+ 2.96	85 21 15.9	+ 2.2
η.....	4.5	15 34 31.47	+ 3.36	105 7 25.4	+ 11.9	γ Telescopii.....	4	17 38 17.49	+ 4.07	126 59 21.3	+ 1.9
α SERPENTIS...	2.3	15 35 54.05	+ 2.94	83 1 59.1	+ 11.8	γ Ophiuchi.....	4	17 39 22.36	+ 3.00	87 13 17.1	+ 1.8
λ.....	4.5	15 38 12.02	+ 2.92	82 6 29.5	+ 11.6	μ Herculis.....	4	17 39 48.60	+ 2.37	62 10 27.2	+ 2.6
β Serpentis.....	3.4	15 38 20.53	+ 2.76	74 2 25.4	+ 11.6	υ Ophiuchi.....	4	17 49 40.25	+ 3.30	99 44 39.6	+ 0.9
χ Lupi.....	4.5	15 40 10.66	+ 3.78	123 6 5.5	+ 11.5	θ Herculis.....	4	17 50 25.62	+ 2.05	52 43 19.0	+ 0.8
μ Serpentis.....	3.4	15 40 45.42	+ 3.12	92 54 11.9	+ 11.4	ξ Draconis.....	3.4	17 50 35.62	+ 1.02	33 5 52.5	+ 0.8
κ.....	4	15 41 5.44	+ 2.70	71 19 39.5	+ 11.4	ξ Herculis.....	4	17 51 9.67	+ 2.32	60 43 40.4	+ 0.8
ι.....	3	15 42 20.88	+ 2.97	85 0 15.0	+ 11.3	67 Ophiuchi.....	4	17 52 8.11	+ 3.00	87 3 10.5	+ 0.7
δ Coronæ Bor..	4.5	15 42 28.07	+ 2.52	63 24 20.5	+ 11.3	γ DRACONIS.....	2	17 52 39.78	+ 1.39	38 29 16.6	+ 0.6
θ Libræ.....	4.5	15 44 9.63	+ 3.39	106 13 21.3	+ 11.2	2 γ Sagittarii.....	4	17 54 53.57	+ 3.85	120 24 51.7	+ 0.4
ε Scorpii.....	4	15 46 24.52	+ 3.68	118 42 24.6	+ 11.0	70 Ophiuchi.....	4.5	17 56 52.00	+ 3.01	87 27 10.4	+ 1.4
π.....	3.4	15 48 35.24	+ 3.61	115 36 57.2	+ 10.9	72.....	4	17 59 17.63	+ 2.84	80 27 11.8	+ 0.1
γ Serpentis.....	3	15 48 36.37	+ 2.74	73 46 39.0	+ 12.2	ο Herculis.....	4	18 0 54.90	+ 2.34	61 15 17.8	- 0.1
δ Scorpii.....	3	15 50 17.76	+ 3.52	112 7 45.5	+ 10.7	1 μ Sagittarii.....	3.4	18 3 36.06	+ 3.58	111 5 38.3	- 0.3

ASTRONOMY.

RIGHT ASCENSIONS AND NORTH POLAR DISTANCES OF 529 STARS.

STARS.	Mag.	R. A.		Annual Precession.	N. P. D.			Annual Precession.	STARS.	Mag.	R. A.		Annual Precession.	N. P. D.			Annual Precession.						
	S.	H.	M. S.	S.	°	'	"	"		S.	H.	M. S.	S.	°	'	"	"						
β Telescopii.....	4	18	6	7.42	+	4.07	126	48	40.7	—	0.5	η Cephei.....	3.4	20	41	49.30	+	1.22	28	49	10.1	—	13.8
δ Sagittarii.....	3.4	18	10	6.75	+	3.84	119	53	23.9	—	0.9	μ Aquarii.....	4.5	20	43	28.81	+	3.24	99	36	54.2	—	13.1
η Serpente.....	4	18	12	31.05	+	3.09	92	56	7.6	—	0.4	32 Vulpeculæ....	4.5	20	47	19.06	+	2.55	62	35	3.9	—	13.4
ε Sagittarii.....	3	18	12	53.39	+	3.98	124	27	24.3	—	1.1	γ Cygni.....	4	20	50	50.42	+	2.23	49	29	1.1	—	13.6
κ Lyrae.....	4.5	18	13	54.43	+	2.10	54	0	25.0	—	1.2	ξ 1 } 61 CYGNI.....	4 5.6	20	58	45.09	+	2.17	46	44	48.3	—	14.1
λ Sagittarii.....	4	18	17	28.77	+	3.70	115	30	20.9	—	1.5	2 } ζ δ Equulei.....	6 3 4.5	20	58	18.74	+	2.77	52	4	54.3	—	17.4
χ Draconis.....	4.5	18	24	7.12	—	1.07	17	20	34.0	—	2.1	α σ Cygni.....	2 4.5	21	5	42.32	+	2.55	60	27	58.2	—	14.5
ζ URSÆ MIN.....	3	18	27	8.53	+	19.16	3	24	53.3	—	2.4	ν 1 Pegasi.....	3 4	21	6	12.13	+	2.92	80	40	36.9	—	14.6
α LYRÆ.....	1	18	31	11.08	+	2.03	51	22	10.5	—	2.7	α CEPHEI.....	4.5	21	7	19.59	+	3.00	85	26	59.6	—	14.6
φ Sagittarii.....	4.5	18	35	2.05	+	3.75	117	9	20.1	—	3.1	ζ Capricorni.....	4.5	21	10	44.75	+	2.35	51	18	50.9	—	14.8
β LYRÆ.....	3	18	43	48.37	+	2.21	56	49	45.8	—	3.8	β AQUARI.....	4.5	21	10	55.97	+	2.46	55	48	46.3	—	14.8
σ Sagittarii.....	3	18	44	43.27	+	3.72	116	29	53.2	—	3.9	γ Capricorni.....	4	21	14	13.65	+	2.76	70	55	5.2	—	15.0
1 δ Serpente.....	4.5	18	47	46.18	+	2.98	86	0	38.5	—	4.1	ι Piscis Aust....	3	21	14	30.99	+	1.45	28	7	57.7	—	15.0
2 δ ζ Sagittarii.....	5 3.4	18	47	47.54 18 51 47.62	+	2.98 3.82	86 120	0 6	43.4 46.7	—	4.1 4.5	ε Pegasi.....	4	21	16	56.92	+	3.44	113	8	29.8	—	15.2
ε Aquilæ.....	3.4	18	51	54.53	+	2.73	75	9	20.2	—	4.5	β AQUARI.....	3	21	22	36.24	+	3.15	96	18	51.0	—	15.5
γ Lyrae.....	3	18	52	35.12	+	2.24	57	32	17.8	—	4.6	β CEPHEI.....	3	21	26	26.12	+	0.81	20	11	4.0	—	15.7
σ Sagittarii.....	4.5	18	54	29.59	+	3.59	111	58	52.2	—	4.7	γ Capricorni.....	4	21	30	39.89	+	3.32	107	25	29.7	—	15.9
τ λ Aquilæ.....	4 3	18	56	19.40 18 57 13.63	+	3.76 3.18	117	54	32.6 95 7 46.5	—	4.9 5.0	ι Piscis Aust....	4.5	21	34	47.96	+	3.60	123	47	49.7	—	16.2
ζ AQUILÆ.....	3	18	57	35.86	+	2.75	76	22	56.8	—	5.0	1 π Cygni.....	2.3	21	35	50.27	+	2.94	80	54	0.6	—	16.2
π Sagittarii.....	4.5	18	59	39.06	+	3.57	111	17	6.0	—	5.2	9 Pegasi.....	4.5	21	36	4.07	+	2.12	39	35	0.1	—	16.2
δ DRACONIS.....	3	19	12	29.67	+	0.02	22	38	14.7	—	6.2	η δ Capricorni.....	4 3.4	21	36	27.90	+	2.83	73	25	32.5	—	16.2
κ Cygni.....	4	19	13	10.34	+	1.38	36	56	31.5	—	6.3	τ Cephei.....	4	21	36	57.15	+	2.71	65	7	57.4	—	16.3
δ AQUILÆ.....	3.4	19	16	55.57	+	3.01	87	13	1.2	—	6.6	σ α AQUARI.....	4.5 3	21	37	38.98	+	3.30	106	53	36.4	—	16.3
τ Draconis.....	4.5	19	18	46.68	—	1.06	16	57	45.8	—	6.8	ι ι Pegasi.....	4.5 4	21	39	24.19	+	0.89	19	28	14.0	—	16.4
π 6 Vulpeculæ....	4 4	19	19	46.94 19 21 38.05	+	0.33 2.50	24	36	43.9 65 40 25.0	—	6.8 7.0	δ 2 π ζ Cephei.....	4.5 4 4	21	40	32.89	+	1.73	29	39	41.8	—	16.4
1 β Cygni.....	3	19	23	52.00	+	2.42	62	23	30.7	—	7.2	α ι Pegasi.....	3 4	21	57	3.09	+	3.09	91	8	30.4	—	17.2
μ Aquilæ.....	4.5	19	25	47.10	+	2.92	82	58	31.1	—	7.3	ι 2 π ζ Cephei.....	4.5 4 4	21	57	14.94	+	3.25	104	41	23.7	—	17.2
2 h Sagittarii.....	4.5	19	26	21.34	+	3.65	115	14	58.2	—	7.4	δ 2 π ζ Cephei.....	4 4 4	22	1	14.94	+	2.76	65	28	54.6	—	17.3
κ Aquilæ.....	4	19	27	44.60	+	3.23	97	23	53.1	—	7.5	ι 2 π ζ Cephei.....	4 4 4	22	1	6.27	+	3.01	84	38	4.5	—	17.4
δ Cygni.....	4	19	31	52.93	+	1.61	40	10	8.1	—	7.8	2 π ζ Cephei.....	4 4	22	2	37.49	+	2.65	57	39	10.0	—	17.5
α Sagittæ.....	4	19	32	30.03	+	2.68	72	22	15.4	—	7.9	ζ Cephei.....	4.5	22	2	26.68	+	2.06	32	38	5.2	—	17.6
φ Cygni.....	4	19	32	39.84	+	2.37	60	13	59.1	—	7.9	δ Aquarii.....	4	22	4	58.13	+	2.06	32	38	5.2	—	17.6
γ AQUILÆ.....	3	19	38	10.70	+	2.85	79	47	40.5	—	8.3	ε Cephei.....	4.5	22	7	51.45	+	3.16	98	37	33.1	—	17.7
δ Cygni.....	3.4	19	39	39.81	+	1.87	45	16	48.4	—	8.4	γ Aquarii.....	4	22	8	47.26	+	2.14	33	48	7.6	—	17.7
δ Sagittæ.....	4	19	39	48.60	+	2.67	71	52	46.0	—	8.5	31 Pegasi.....	4.5	22	12	52.49	+	3.09	92	14	25.5	—	17.9
α AQUILÆ.....	1.2	19	42	29.36	+	2.93	81	34	26.8	—	8.7	3 Lacertæ.....	4	22	13	9.25	+	2.95	78	38	52.9	—	17.9
η β γ Sagittæ.....	4 3.4 4.5	19	43	48.61 46 57.84 51 11.93	+	3.06 2.95 2.66	89 84 0 40.6 70 57 49.1	25 40.6 49.1	26.2 — 8.5 — 9.3	— 8.8 — 8.5 — 9.3	8.8 8.5 9.3	ζ Aquarii.....	4	22	16	53.42	+	2.34	38	37	13.0	—	18.0
62 Sagittarii.....	4.5	19	52	11.71	+	3.70	118	10	25.5	—	9.4	β Piscis Aust....	4	22	20	4.66	+	3.08	90	53	13.5	—	18.2
δ Aquilæ.....	3.4	20	2	31.92	+	3.10	91	19	7.0	—	10.2	δ Cephei.....	4	22	21	49.44	+	3.43	123	12	53.7	—	18.2
1 α CAPRICORNII..	4	20	8	13.17	+	3.33	103	1	35.3	—	10.6	7 Lacertæ.....	4.5	22	22	52.48	+	2.20	32	27	7.4	—	18.3
2 ο Cygni.....	4	20	8	16.81	+	1.89	43	46	13.9	—	10.6	η Aquarii.....	4	22	24	18.29	+	2.44	40	35	21.5	—	18.3
2 α CAPRICORNII..	3	20	8	37.00	+	3.34	103	3	52.4	—	10.7	18 Piscis Aust....	4	22	26	37.26	+	3.08	90	59	27.3	—	18.4
23 Vulpeculæ....	4.5	20	8	43.64	+	2.48	62	42	7.9	—	10.7	ζ Pegasi.....	3	22	26	37.26	+	3.08	90	59	27.3	—	18.4
33 Cygni.....	4.5	20	9	26.56	+	1.39	33	56	58.7	—	10.7	ι λ Aquarii.....	4 4	22	43	38.92	+	2.12	24	41	31.5	—	18.9
32 2 β Capricorni.....	4.5 3.4	20	10	13.08 11 27.25	+	1.85 3.38	42 105	48 18	15.1 39.2	— —	10.8 10.9	δ ο Andromedæ...	3 4	22	43	44.52	+	3.13	98	28	53.5	—	18.9
κ Cephei.....	4.5	20	14	27.61	+	1.88	12	48	15.6	—	11.1	56 β Pegasi.....	4.5 2	22	45	37.35	+	3.20	106	43	18.9	—	19.0
γ Cygni.....	3	20	16	7.89	+	2.15	50	16	59.4	—	11.2	ο Andromedæ...	4	22	48	14.31	+	3.34	120	31	14.4	—	19.1
41 ε Delphini.....	4.5 4	20	22 25	27.17 5.49	+	2.45 2.86	60 79	11 16	37.8 8.0	— —	11.7 11.9	β Pegasi.....	2	22	54	7.01	+	2.73	48	35	8.3	—	19.2
β δ α α CYGNI.....	4 4.5 3.4 1	20	29 30 31 35	34.71 42.60 44.87 38.38	+	2.80 2.83 2.78 2.04	75 77 74 45	59 16 40 19	26.2 33.7 56.0 24.7	— — — —	12.2 12.3 12.3 12.6	α PEGASI.....	2	22	55	32.60	+	2.88	62	50	15.1	—	19.3
ψ Capricorni.....	4.5	20	36	1.15	+	3.57	115	52	27.9	—	12.6	56 88 Aquarii.....	4.5 4.5	22	56	17.98	+	2.98	75	42	25.8	—	19.3
ε Aquarii.....	4.5	20	38	28.19	+	3.25	100	6	43.1	—	12.8	γ λ Aquarii.....	4.5 4.5	22	58	50.57	+	2.91	65	26	50.2	—	19.3
3 γ Delphini.....	4 4	20	38 38	45.82 46.38	+	3.17 2.78	95 74	38 28	39.3 58.8	— —	12.8 12.8	1 α ANDROMEDÆ	4.5 1	23	0	22.36	+	3.21	112	5	33.2	—	19.4
α Microscopii...	4.5	20	39	19.71	+	3.77	124	24	14.9	—	12.8	γ Cephei.....	3	23	8	21.24	+	3.11	87	38	40.8	—	19.5
ε Cygni.....	3	20	39	20.11	+	2.39	56	39	41.0	—	12.8	1 α ANDROMEDÆ	4.5 1	23	29	16.19	+	2.89	44	27	42.9	—	19.9
												ο Piscium.....	4.5	23	31	12.63	+	3.05	85	17	38.3	—	19.3
												γ Cephei.....	3	23	32	26.52	+	2.39	13	18	57.1	—	19.9
												ω Piscium.....	4.5	23	50	35.17	+	3.06	84	4	38.5	—	20.0
												30 2 Ceti.....	4.5 4	23	53	14.60	+	3.07	96	57	30.3	—	20.0
												α ANDROMEDÆ	1	23	55	1.61	+	3.08	108	16	53.2	—	20.0
																		61	50	53.5	—	20.0	

Practical Astronomy. The preceding catalogue has been selected from one containing the approximate right ascensions and north polar distances of 720 stars, from observations made with two microscopes. This, however, is considered by the astronomer royal, Mr Pond, only as a first approximation to a more perfect catalogue, which is now forming at Greenwich, from observations made with two mural circles and six microscopes. A German astronomer, Bode, has published a catalogue of 17,240 stars, with their right ascensions and declinations, as a sequel to his *Uranogra-*

phia, which exhibits engraved figures of the constellations. **Practical Astronomy.** The Memoirs of the Astronomical Society of London contain a catalogue of nearly 3000 stars, with accompanying tables, by Mr Baily, who has stated every particular relating to it in a most elaborate preface. This is fully adequate to the wants of practical astronomers: but the principal astronomers in Europe have undertaken a survey of the heavens, in which each has chosen a section; and the completion of the labour will farther advance this part of the science.

SECT. II.—Table for Converting Intervals of Sidereal Time into Intervals of Mean Solar Time.

HOURS.				MINUTES.								SECONDS.			
M.	S.	M.	S.	S.	S.	S.	S.	S.	S.	S.	S.	S.	S.	S.	S.
1	0 9-830	13	2 7-784	1	0-164	13	2-130	25	4-096	37	6-062	49	8-027	5	0-014
2	0 19-659	14	2 17-614	2	0-328	14	2-294	26	4-259	38	6-225	50	8-191	10	0-027
3	0 29-489	15	2 27-443	3	0-491	15	2-457	27	4-423	39	6-389	51	8-355	15	0-041
4	0 39-318	16	2 37-273	4	0-655	16	2-621	28	4-587	40	6-553	52	8-519	20	0-055
5	0 49-148	17	2 47-103	5	0-819	17	2-785	29	4-751	41	6-717	53	8-683	25	0-068
6	0 58-977	18	2 56-932	6	0-983	18	2-949	30	4-915	42	6-881	54	8-847	30	0-082
7	1 8-807	19	3 6-762	7	1-147	19	3-113	31	5-079	43	7-044	55	9-010	35	0-096
8	1 18-636	20	3 16-591	8	1-311	20	3-277	32	5-242	44	7-208	56	9-174	40	0-109
9	1 28-466	21	3 26-421	9	1-474	21	3-440	33	5-406	45	7-372	57	9-338	45	0-123
10	1 38-296	22	3 36-250	10	1-638	22	3-604	34	5-570	46	7-536	58	9-502	50	0-137
11	1 48-125	23	3 46-080	11	1-802	23	3-768	35	5-734	47	7-700	59	9-666	55	0-150
12	1 57-955	24	3 55-909	12	1-966	24	3-932	36	5-898	48	7-864	60	9-830	60	0-164

The numbers in this table express the acceleration of the fixed stars. Its use is to convert any interval of sidereal into mean solar time.

RULE.—Take from the table the acceleration corresponding to the hours, the minutes, and the seconds; subtract their sum from the given sidereal interval; the remainder will express its value in mean solar time.

EXAMPLE.—Convert 7^h. 14^m. 51^s. sidereal time into solar time.

	H.	M.	S.	M.	S.
The acceleration on...	7	0	0-00	is	1 8-807
.....		14	0-00		2-294
.....			51-00		1-139
From sidereal time....	7	14	51-00		1 11-240
Subtract acceleration.		1	11-24		

Mean solar time.....7 12 39-76, the answer.

The reduction of sidereal to solar time is constantly wanted in the solution of the following important problem in Practical Astronomy, viz.

To find the mean solar hour when any star in the preceding catalogue will be on the meridian at a given place, on a given day, in a given year.

SOLUTION.—The right ascension of the star at the given time is the sidereal hour of its transit. The sun's R. A. in the Nautical Almanac, for the given time, is the sidereal hour of its transit at Greenwich on that day; from this, and the longitude of the given place, the sun's R. A., that is, the sidereal hour of its transit at that place, may be found. Then the sidereal interval between the sun's transit and that of the star will be the difference between the R. A. of the star and that of the sun. This converted into solar time will give the mean solar interval be-

tween the sun's transit and that of the star: to this the equation of time must be applied, and the result will be the hour of the star's transit reckoned from mean moon.

EXAMPLE.—At what hour will α Aquilæ pass the meridian of Edinburgh on 1st October 1831?

The proposed time is about 1 $\frac{3}{4}$ year after the epoch of the catalogue. The correction for change of R. A. by precession will therefore be $+ 2^s.93 \times 1.75 = + 5^s.12$, and the star's R. A. will be 19^h. 42^m. 34^s.5. Again, the sun's R. A. at Greenwich for the given day is 12^h. 27^m. 41^s.3, and its daily increase is 3^m. 37^s.5. Now the longitude of Edinburgh is, in time, 12^m. 44^s. west from Greenwich, and corresponding to this, the change in the sun's R. A. will be 1^s.8; therefore the sun's R. A. when on the meridian of Edinburgh will be 12^h. 27^m. 43^s.1.

	H.	M.	S.
From R. A. star.....	19	42	34.5
Subtract R. A. sun.....	12	27	43.1
Difference in sidereal time.....	7	14	51.4
Correct for acceleration.....		1	11.9
From apparent time.....	7	13	39.5
Subtract equation of time.....		10	9.3
Time of star's transit.....	7	3	30.2

Hence it appears that the star will pass the meridian of Edinburgh at 7^h. 3^m. 30^s. after mean noon. Here no corrections are made on the R. A. of the star for aberration and nutation; but these are too small to be sensible, except by good astronomical instruments.

By this problem the astronomer finds the error and rate of his clock, taking in, however, aberration and nutation, which need not be noticed in ordinary estimations of time.

SECT. III.—Table of Atmospheric Refractions, with Corrections for the Height of the Barometer and Thermometer.

App. Altitude.	Refr. B. 30 Th. 50°.	Diff. for 1' Alt.	Diff. for +1 B.	Diff. for -1° Fa.	App. Altitude.	Refr. B. 30 Th. 50°.	Diff. for 1' Alt.	Diff. for +1 B.	Diff. for -1° Fa.	App. Altitude.	Refr. B. 30 Th. 50°.	Diff. for 1' Alt.	Diff. for +1 B.	Diff. for -1° Fa.	App. Altitude.	Refr. B. 30 Th. 50°.	Diff. for 1' Alt.	Diff. for +1 B.	Diff. for -1° Fa.
0 0	33 51	11.7	74	8.1	4 0	11 52	2.2	24.1	1.70	12 0	4 28.1	0.38	9.00	0.556	42	1 4.6	0.038	2.16	0.130
5	32 53	11.3	71	7.6	10	11 30	2.1	23.4	1.64	10	4 24.4	0.37	8.86	0.548	43	1 2.4	0.036	2.09	0.125
10	31 58	10.9	69	7.3	20	11 10	2.0	22.7	1.58	20	4 20.8	0.36	8.74	0.541	44	1 0.3	0.034	2.02	0.120
15	31 5	10.5	67	7.0	30	10 50	1.9	22.0	1.53	30	4 17.3	0.35	8.63	0.533	45	0 58.1	0.034	1.94	0.117
20	30 13	10.1	65	6.7	40	10 32	1.8	21.3	1.48	40	4 13.9	0.33	8.51	0.524	46	56.1	0.033	1.88	0.112
25	29 24	9.7	63	6.4	50	10 15	1.7	20.7	1.43	50	4 10.7	0.32	8.41	0.517	47	54.2	0.032	1.81	0.108
30	28 37	9.4	61	6.1	5 0	9 58	1.6	20.1	1.38	13 0	4 7.5	0.31	8.30	0.509	48	52.3	0.031	1.75	0.104
35	27 51	9.0	59	5.9	10	9 42	1.5	19.6	1.34	10	4 4.4	0.31	8.20	0.503	49	50.5	0.030	1.69	0.101
40	27 6	8.7	58	5.6	20	9 27	1.5	19.1	1.30	20	4 1.4	0.30	8.10	0.496	50	48.8	0.029	1.63	0.097
45	26 24	8.4	56	5.4	30	9 11	1.4	18.6	1.26	30	3 58.4	0.30	8.00	0.490	51	47.1	0.028	1.58	0.094
50	25 43	8.0	55	5.1	40	8 58	1.3	18.1	1.22	40	3 55.5	0.29	7.89	0.482	52	45.4	0.027	1.52	0.090
55	25 3	7.7	53	4.9	50	8 45	1.3	17.6	1.19	50	3 52.6	0.29	7.79	0.476	53	43.8	0.026	1.47	0.088
1 0	24 25	7.4	52	4.7	6 0	8 32	1.2	17.2	1.15	14 0	3 49.9	0.28	7.70	0.469	54	42.2	0.026	1.41	0.085
5	23 48	7.1	50	4.6	10	8 20	1.2	16.8	1.11	10	3 47.1	0.28	7.61	0.464	55	40.8	0.025	1.36	0.082
10	23 13	6.9	49	4.5	20	8 9	1.1	16.4	1.09	20	3 44.4	0.27	7.52	0.458	56	39.3	0.025	1.31	0.079
15	22 40	6.6	48	4.4	30	7 58	1.1	16.0	1.06	30	3 41.8	0.26	7.43	0.453	57	37.8	0.025	1.26	0.076
20	22 8	6.3	46	4.2	40	7 47	1.0	15.7	1.03	40	3 39.2	0.26	7.34	0.448	58	36.4	0.024	1.22	0.073
25	21 37	6.1	45	4.0	50	7 37	1.0	15.3	1.00	50	3 36.7	0.25	7.26	0.444	59	35.0	0.024	1.17	0.070
30	21 7	5.9	44	3.9	7 0	7 27	1.0	15.0	0.98	15 0	3 34.3	0.24	7.18	0.439	60	33.6	0.023	1.12	0.067
35	20 38	5.7	43	3.8	10	7 17	0.9	14.6	0.95	30	3 27.3	0.22	6.95	0.424	61	32.3	0.022	1.08	0.065
40	20 10	5.5	42	3.6	20	7 8	0.9	14.3	0.93	16 0	3 20.6	0.21	6.73	0.411	62	31.0	0.022	1.04	0.062
45	19 43	5.3	40	3.5	30	6 59	0.8	14.1	0.91	30	3 14.4	0.20	6.51	0.399	63	29.7	0.021	0.99	0.060
50	19 17	5.1	39	3.4	40	6 51	0.8	13.8	0.89	17 0	3 8.5	0.19	6.31	0.386	64	28.4	0.021	0.95	0.057
55	18 52	4.9	39	3.3	50	6 43	0.8	13.5	0.87	30	3 2.9	0.18	6.12	0.374	65	27.2	0.020	0.91	0.055
2 0	18 29	4.8	38	3.2	8 0	6 35	0.7	13.3	0.85	18 0	2 57.6	0.17	5.98	0.362	66	25.9	0.020	0.87	0.052
5	18 5	4.6	37	3.1	10	6 28	0.7	13.1	0.83	19 0	2 47.7	0.16	5.61	0.340	67	24.7	0.020	0.83	0.050
10	17 43	4.4	36	3.0	20	6 21	0.7	12.8	0.82	20	2 38.7	0.15	5.31	0.322	68	23.5	0.020	0.79	0.047
15	17 21	4.3	36	2.9	30	6 14	0.7	12.6	0.80	21	2 30.5	0.13	5.04	0.305	69	22.4	0.020	0.75	0.045
20	17 0	4.1	35	2.8	40	6 7	0.7	12.3	0.79	22	2 23.2	0.12	4.79	0.290	70	21.2	0.020	0.71	0.043
25	16 40	4.0	34	2.8	50	6 0	0.6	12.1	0.77	23	2 16.5	0.11	4.57	0.276	71	19.9	0.020	0.67	0.040
30	16 21	3.9	33	2.7	9 0	5 54	0.6	11.9	0.76	24	2 10.1	0.10	4.35	0.264	72	18.8	0.019	0.63	0.038
35	16 2	3.7	33	2.7	10	5 47	0.6	11.7	0.74	25	2 4.2	0.09	4.16	0.252	73	17.7	0.018	0.59	0.036
40	15 43	3.6	32	2.6	20	5 41	0.6	11.5	0.73	26	1 58.8	0.09	3.97	0.241	74	16.6	0.018	0.56	0.033
45	15 25	3.5	32	2.5	30	5 36	0.6	11.3	0.71	27	1 53.8	0.08	3.81	0.230	75	15.5	0.018	0.52	0.031
50	15 8	3.4	31	2.4	40	5 30	0.5	11.1	0.71	28	1 49.1	0.08	3.65	0.219	76	14.4	0.018	0.48	0.029
55	14 51	3.3	30	2.3	50	5 25	0.5	11.0	0.70	29	1 44.7	0.07	3.50	0.209	77	13.4	0.017	0.45	0.027
3 0	14 35	3.2	30	2.3	10 0	5 20	0.5	10.8	0.69	30	1 40.5	0.07	3.36	0.201	78	12.3	0.017	0.41	0.025
5	14 19	3.1	29	2.2	10	5 15	0.5	10.6	0.67	31	1 36.6	0.06	3.23	0.193	79	11.2	0.017	0.38	0.023
10	14 4	3.0	29	2.2	20	5 10	0.5	10.4	0.65	32	1 33.0	0.06	3.11	0.186	80	10.2	0.017	0.34	0.021
15	13 50	2.9	28	2.1	30	5 5	0.5	10.2	0.64	33	1 29.5	0.06	2.99	0.179	81	9.2	0.017	0.31	0.018
20	13 35	2.8	28	2.1	40	5 0	0.5	10.1	0.63	34	1 26.1	0.05	2.88	0.173	82	8.2	0.017	0.27	0.016
25	13 21	2.7	27	2.0	50	4 56	0.4	9.9	0.62	35	1 23.0	0.05	2.78	0.167	83	7.1	0.017	0.24	0.014
30	13 7	2.7	27	2.0	11 0	4 51	0.4	9.8	0.60	36	1 20.0	0.05	2.68	0.161	84	6.1	0.017	0.20	0.012
35	12 53	2.6	26	2.0	10	4 47	0.4	9.6	0.59	37	1 17.1	0.05	2.58	0.155	85	5.1	0.017	0.17	0.010
40	12 41	2.5	26	1.9	20	4 43	0.4	9.5	0.58	38	1 14.4	0.05	2.49	0.149	86	4.1	0.017	0.14	0.008
45	12 28	2.4	25	1.9	30	4 39	0.4	9.4	0.57	39	1 11.8	0.04	2.40	0.144	87	3.1	0.017	0.10	0.006
50	12 16	2.4	25	1.9	40	4 35	0.4	9.2	0.56	40	1 9.3	0.04	2.32	0.139	88	2.0	0.017	0.07	0.004
55	12 3	2.3	25	1.8	50	4 31	0.4	9.1	0.55	41	1 6.9	0.04	2.24	0.134	89	1.0	0.017	0.03	0.002

Explanation of the Table of Refractions.

This table is computed upon principles explained by the late Dr Young in the *Philosophical Transactions* for 1819; and it appears to agree more perfectly with the latest observations than any other table before published.

The apparent altitude being found in the first column, the second shows the refraction when the barometer stands at 30 inches, which is its mean height on the level of the sea, and the thermometer at 50° of Fahrenheit. The third column contains the difference to be subtracted or added for every minute of altitude, reckoned from the nearest number in the first column. The fourth shows the number of seconds to be added for every inch that the height of the barometer exceeds 30, or to be subtracted for each inch that it wants of 30; and the last contains the number of seconds to be subtracted for each degree that the thermometer stands above 50°, or to be added for each degree that its height wants of 50°.

If great accuracy be required, we must also deduct from the observed height of the barometer .003 inch for each degree that the thermometer near it is above 50°, and add an equal quantity for an equal depression. In fact, however, the table, as it now stands, is found to require the temperature to be estimated from the height of the thermometer within; and if we employed the height of the thermometer without, which would be more consistent with the theory, it would probably be necessary to suppose the standard temperature of the table 48° only (or rather 47°), instead of 50°.

Examples.

1. At 7° 18' 13", barometer 29.87, thermometer 66°, the refraction is 6' 52".26, from twenty-two observations of Bradley.

2. At 19° 18' 19", barometer 30.045, thermometer 34°, the refraction is 2' 51".5, from three observations of Bradley.

3. At 13° 43', barometer 29.85, thermometer 45°, the refraction is 3' 55".85, from 156 observations of Mr Pond.

1. Alt. 7° 20' R. 7' 8"	Diff. Alt. .9	B. 14".3	Th. .93
+ 1.62	1' 47" = 1' .8	— .13	— 16
7 9.62	+ 1 .62	1 .86	14.88
16.74			1.86
6 52.88			16.74
6 52.26			

Error..... 0.62

2. Alt. 19° R. 2' 47".7	Diff. Alt. .16	B. 5".61	Th. .34
— 2 .93	18' 19" = 18 .3	+ .045	+ 16
2 44 .77	— 2.93	.262	5.44
.25			
5 .44			

Error 1".0 2 50.46

3. Alt. 13° 40' R. 3' 55".5	Diff. Alt. .29	B. 7".39	Th. .482
+ .36	3	.15	5
3 55 .86	— 87	— 1 .18	+ 2 .41
3 55 .85		.87	2 .05
Error..... .01		2 .05	+ .36

There are two principal objects to be accomplished by astronomical instruments; the one is the extension and improvement of the science; and the other its application to geography, navigation, and the ordinary wants of society. Here we give the name astronomical instruments to such as in their application are directed to the heavenly bodies, as a telescope is directed to a star, and the axis of a sun-dial to the pole; but we do not consider as astronomical instruments *orreries*, and machines composed of wheels and pinions, such as exhibit imperfectly representations of the celestial motions. Globes are indeed appropriate furniture in an observatory, because they truly exhibit the relative positions of the stars and the different countries; and they serve to resolve approximately the different problems of the sphere. But complex orreries and planetary clocks are mere playthings. They excite admiration by the ingenuity displayed in their construction, but they are of no practical use. Showmen pretend to teach astronomy by their assistance; but their inutility in giving just notions of the dimensions and magnitudes of the bodies which form the solar system may be easily conceived by reflecting, that if in an orrery the earth be represented by a sphere one inch in diameter, the representation of the sun should be nine feet; also, that if the representation of Mercury describe a circle of about four inches radius, then the orbit of Uranus should have its radius sixteen feet.

Judicious teachers of astronomy may, however, employ with advantage simple contrivances to facilitate the acquiring of correct notions of the celestial motions; but they will direct the attention to a single object at a time, and not attempt to exhibit all the phenomena of the heavens at once. Wooden wheels and catgut bands are just as useful for the purpose in question as metallic wheels and pinions. A globe moved by the hand round a candle will serve to show the changes of the seasons; and in like manner the phases of the moon, her nodes and their motion, and the nature of eclipses, may be all explained by simple and easy contrivances.

1. Astronomical Telescope.

In a subsequent part of this work the theory of the telescope, and the various kinds of telescopes, will be fully explained. As, however, the telescope forms an essential part of almost all complex astronomical instruments, it will be proper to explain here in a general way its principles and use.

The astronomical telescope is composed of two principal parts, the *object-glass*, and the *eye-glass* or *eye-piece*. These are in opposite ends of a tube; and in its application the former is next the object, and the latter next the eye. In telescopes of the best construction the object-glass is composed of two and sometimes of three pieces. (See ACHROMATIC GLASSES.) We shall here, however, suppose it of the simplest form; that is, a very thin double convex glass, the opposite sides being portions of spherical surfaces.

Let ABDE (Plate XCIII. fig. 131) be a lens of this form, C being the centre of a sphere, of which ABE is a portion of the surface. Let L be any point in an object to be viewed with the telescope, and let a ray of light proceeding from L fall perpendicularly on the convex surface in B: it will pass through the glass without being turned out of its direction, and will proceed straight forward on the prolongation of the line LBD.

Let another ray LI fall obliquely on the convex surface

at I: by the principles of optics this will be *refracted*, that is, turned out of the direction LI, and take a new direction I'P. Draw CI to the centre; the new direction will be such that the sine of the angle of incidence MIL or CIL will be to the sine of the refracted angle CIP or CIP in the constant ratio of a given number n to 1.

We have therefore

$$n = \frac{\sin. CIL}{\sin. CIP} = \frac{\sin. CIL}{\sin. ICL} \cdot \frac{\sin. ICP}{\sin. CIP} = \frac{CL}{IL} \cdot \frac{IP}{CP}.$$

Let us suppose the point I to be near B; then IP=BP nearly, and IL=BL nearly, and we have

$$n = \frac{CL \cdot BP}{BL \cdot CP}, \text{ nearly} \dots \dots \dots (1)$$

When the ray arrives at the concave surface ADE, it suffers a second refraction in passing into the air, and changes its direction from I'P into a new direction I'L. Let C' be the centre of a sphere, of which ADE is a part of the surface: draw the radius C'I, and we shall have $\sin. C'TL : \sin. C'TP :: n : 1$; and therefore

$$n = \frac{\sin. C'I'L}{\sin. C'I'P} = \frac{\sin. C'I'L}{\sin. I'C'L} \cdot \frac{\sin. I'C'P}{\sin. C'I'P} = \frac{C'L}{I'L} \cdot \frac{IP}{C'P}.$$

We suppose the arcs IB, I'D, to be small; therefore I'P = PD nearly, and I'L = DL' nearly; hence

$$n = \frac{C'L \cdot PD}{DL' \cdot C'P}, \text{ nearly.}$$

Since the thickness of the lens is supposed to be inconsiderable, we may assume that PD = PB nearly, and that DL' = BL nearly, and then we have

$$n = \frac{C'L \cdot PB}{BL \cdot C'P} \dots \dots \dots (2)$$

Let $r = CB$, $r' = C'B$, $\Delta = BL$, $\Delta' = BL'$, $v = PB$, and equations (1) and (2) become

$$n = \frac{v(r + \Delta)}{\Delta(v - r)}; \quad n = \frac{v(r' + \Delta')}{\Delta'(v + r')};$$

from these we obtain

$$\frac{n}{v} = \frac{n-1}{r} - \frac{1}{\Delta}, \text{ and } \frac{n}{v} = \frac{1}{\Delta'} - \frac{n-1}{r'};$$

and hence

$$\frac{1}{\Delta} + \frac{1}{\Delta'} = (n-1) \left\{ \frac{1}{r} + \frac{1}{r'} \right\}.$$

When a ray of light passes out of air into glass, the sine of the angle of incidence is to the sine of the angle of refraction as 3 to 2 nearly, or as $1\frac{1}{2}$ to 1. In this case $n = 1\frac{1}{2}$, and

$$\frac{1}{\Delta} + \frac{1}{\Delta'} = \frac{1}{2} \left(\frac{1}{r} + \frac{1}{r'} \right).$$

This expression will be the very same if we put r instead of r' , and r' instead of r ; also, if we put Δ for Δ' , and Δ' for Δ . Hence we may infer, that whichever of the two convex sides of the object-glass be turned towards the object L, the value of Δ' will be the same for a given value of Δ ; also, that if L' be the *focus* to which rays issuing from L converge after refraction, then L will be the focus to which rays issuing from L' would converge after passing through the object-glass.

If Δ , the distance of L from the object-glass, be very great, then $\frac{1}{\Delta}$ will be very small in respect of $\frac{1}{\Delta'}$; and in

the case of the heavenly bodies $\frac{1}{\Delta}$ vanishes, and we have simply

$$\frac{1}{\Delta'} = \frac{1}{2} \left(\frac{1}{r} + \frac{1}{r'} \right).$$

If we suppose both sides of the object-glass to be alike convex, that is, $r = r'$, then $\Delta' = r$; hence we learn, 1st, that all rays which come from any point whatever of a

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very remote object, and which traverse a double convex glass of equal curvature on both sides, are united by refraction about its centre of sphericity, which is called its *principal focus*; $2d$, that rays which proceed from a point at the centre of sphericity do, after refraction, proceed in lines which may be considered as parallel. All these conclusions are only true approximately. They suppose the convex arcs ABE ADE small, and the thickness of the glass very little; nevertheless they differ but little from truth: the focus L is not indeed a mathematical point, but has a certain magnitude, which varies with the distance of the object and the breadth of the lens.

If we now suppose that two lenses, BD, bd (fig. 132), are adapted to the extremity of a tube, so that their centres of sphericity coincide at the same point F, and that this point and the centres of the lenses are in the same straight line, then, from what has been explained, it follows that rays coming from a distant object L, after passing through the lens BD or object-glass, will be collected at F (which is therefore called the *focus of parallel rays*), and will there form an image of the object L: also, that all the rays, after crossing in the focus F, will proceed forward; but in passing through the second lens or *eye-glass* bd , they will be again refracted, and emerge on the other side in parallel lines; and if they enter an eye now situated at O, these parallel rays will produce distinct vision.

The eye does not see directly the remote object AC, but only its image formed at the focus F, and this in respect to the object is inverted; for the rays proceeding from A and falling on the object-glass at B, are by refraction turned into the direction BF, and meet the glass at δ . In like manner, the rays which are emitted from C, and pass through the object-glass at D, meet the eye-glass on the opposite side at β : thus the object AC and its image formed at F have opposite positions.

The astronomical telescope, then, differs from the common telescope for viewing objects at a distance, in reversing the position of objects seen through it, also the direction of their motions, the upper limb of the sun or moon appearing the lower, and all the heavenly bodies appearing to move from west to east. This, which would be an inconvenience with terrestrial objects, is of no consequence in viewing the stars.

The surface of the object-glass being always much greater than that of the eye-glass, which has a shorter focus, and all the rays which fall on the surface BD of the former being collected on the surface bd of the latter, they are there condensed, and the illumination is increased in the inverse proportion of the areas of the glasses; so that if the intensity of the light which falls on the object-glass be represented by 1, that on the eye-glass will be $\left(\frac{BD}{bd}\right)^2$; hence telescopes in general render objects

more luminous and more easily distinguished. They also magnify objects; for let A be the centre and B the border of an object (fig. 133). The point A is visible to the eye O, by the ray ADaEO which traverses the object-glass D and eye-glass E, but suffers no refraction. (We here do not consider the oblique rays, which, proceeding from A, are collected at the principal focus.) The border B is visible by the ray BD δ at the focus b of the object-glass. This ray meets the eye-glass at d , and is there turned by refraction into the direction de ; and, in emerging from the glass at e , is again refracted to O, its focus, so that OE is parallel to Eb. The image is seen under the angle $eOE = bEa$: but $ab = Da \tan. D$, therefore

$$\tan. E = \frac{Da}{Ea} \tan. D = \frac{R}{r} \tan. D, \text{ or } E = \frac{R}{r} D;$$

R being the radius of sphericity of the object-glass, and r that of the eye-glass. The angle under which the object is seen is therefore increased in the proportion of the two radii, and the magnifying power is the greater, as the radius of the eye-glass is less than that of the object-glass.

Common astronomical telescopes generally magnify from 70 to 100 times; some even magnify 300 times. This, however, must not be understood in a rigorous sense; if, for example, we expect to see the moon 100 times larger with a telescope which is said to magnify 100 times, we may be disappointed. To produce this effect, the telescope ought to magnify more: it only represents the moon under an angle 100 times greater; but it is not by the visual angle alone that we judge of magnitude; our opinion is greatly influenced by the distance at which we suppose the object. When we see an object under the angle AKB (fig. 134), nothing determines whether this object is truly AB, or CD, or EFF; and according as we judge it to be in the first, or second, or third of these positions, or in one more remote, we assign to it magnitudes always increasing although the angle is still the same. But this judgment being uncertain, and such as cannot be subjected to calculation, the magnifying power of a telescope is in practice estimated by the angle of vision, which can always be exactly determined.

Let F be the principal focus of the object-glass C (fig. 135). If the angle HCG is such, that $HG (=2 HF) = 2 CF \tan. HCF$ is equal to the diameter of the interior tube of the telescope, the angle HCG is called the *field of view*: every object whose focal image is greater than HG cannot be seen entirely in the telescope. This happens in the case of the sun and moon when viewed with telescopes of about $8\frac{1}{2}$ feet, such as are used in considerable observatories. In these, the sun's image will be about $9\frac{1}{2}$ inches. This exceeds the diameter of the tube. But the opening is yet more contracted by a perforated diaphragm, which, besides other purposes, serves to cut off the rays irregularly reflected from the inside of the tube, also those which produce colour in the image. To determine the field in view as limited by the diaphragm, then, we have this equation; $2 \tan. HCF = \frac{HG}{CF} = \frac{2 HF}{CF}$. If we put r for HF, the radius of the diaphragm, and R for CF, the radius of sphericity of the object-glass, the field of view

in seconds is $\frac{2r}{R \sin. 1''}$.

2. Dorpat Telescope.

The late Joseph Fraunhofer of Munich, a most skilful artist and experimenter in optics (whose demise in 1826, in the prime of life, was a great loss to science), constructed a magnificent refracting telescope for the observatory of the Imperial University at Dorpat. It was received by Professor Struve in the year 1825, and has since been found to fulfil most satisfactorily his expectation and the intentions of the maker. As this is one of the most magnificent instruments of the kind that has hitherto been constructed, and described by a figure, we have given an engraving of it, copied from the *Memoirs of the Astronomical Society*. (See Plate XCV.)

The object-glass of this telescope is about $9\frac{1}{2}$ inches in diameter, and its focal length about 14 English feet. The main tube is 13.8 feet; and, in addition, there is the small tube which holds the eye-pieces. Of these there are four; the least magnifying power is 175, and the greatest 700. After the telescope was received at Dorpat, a perfect micrometrical apparatus was ordered to be made for it. This was to consist of four annular micrometers, of which two were to be double; a lamp circular micrometer, with four

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Practical Astronomy. eye-pieces; a refracting lamp net micrometer, with position circles, and four eye-pieces.

The frame-work of the stand is made of oak, and the tube of deal, veneered with mahogany. The whole weight of the telescope and its counterpoises is supported at one point, namely, at the common centre of gravity of all the ponderous parts. These weigh 3000 Russian pounds, of which the frame-work contains 1000; the remaining 2000 are so balanced in every position, that the telescope may be turned, with ease and certainty, in every direction towards the heavens.

The basis of the frame is formed of two cross beams, each nine feet seven inches long. The ends of these are seen in the figure at A, B, C, D. They are braced by four smaller bars forming a square, one of which is seen at E. This braced cross is fastened to the floor by eight screws, six of which are seen in the figure. A perpendicular post, about six feet high and seven inches square, is fixed over the centre of the cross, and is propped at the north, east, and west sides by three curved stays, denoted by G, G', G'', which are fixed at their lower ends to the beams of the cross, and at the upper to the vertical post. An inclined beam H of the same thickness rests on the southern end of the meridian beam of the cross, and is attached to the vertical beam in a position parallel to the polar axis. This axis, shown in the figure at I, is a cylinder of steel 39 inches long, and proportionally thick. It turns in two collars, and its lower end, which is rounded and polished, rests on a steel plate attached to the bearing piece K, which is secured to the inclined beam H, and has therefore very little friction, the weight being supported by friction rollers near the common centre of gravity; and a counterpoise L is applied to support the axis in any position. There is a circle 13 inches in diameter, graduated to minutes of time, fixed to the lower end of the axis, and furnished with verniers. The axis of vertical motion of the telescope, which has nearly the dimensions of the polar axis, passes through a brass tube at right angles to the latter; the tube, which is seen at M, forms a part of the frame, and is fastened to the upper end of the polar axis by twelve screws. This axis carries the circle of declination, which is 19 inches in diameter, and is divided to every 10', with a vernier reading 10" or 5" by estimation. The tube of the telescope is fixed to the frame-work nearer to the eye end than the middle, and has two counterpoises attached to levers, which balance the two ends, and prevent the natural tendency of the longer end to bend. The brass frame holding the two axes appears on the figure clamped to the tube by two strong rings, one at each end of the centre of motion. A bent lever, carrying the weight O, embraces by a double ring the near end of the axis of the declination circle. The axis itself carries another weight; and by this and the weight O it is counterpoised. The slow motion in altitude is given to the telescope by a Hooke's joint applied to the screw of the clamp, which has a spring urging it against a strong iron bar P, attached to the end of the cylinder M, that forms a stop to the circle; and a slow equatorial motion is given by a second Hooke's joint taking hold of an endless screw, acting with the racked edge of the hour circle, while a spring presses it into action uniformly, and a lever is employed to raise it out of the rack when necessary. The handles taking hold of these screws extend to the reach of the observer, who can thus point his telescope in right ascension and declination with the same certainty as the best meridian instrument.

A regular sidereal motion is communicated to the instrument by clock-work, which keeps a star apparently at rest in the centre of the field of view; and there is a

contrivance by which the sidereal can be changed into a solar, also to a lunar angular motion. Practical Astronomy.

This almost invaluable instrument cost 10,500 florins (about 950 pounds sterling). The price, although it may appear considerable, yet barely covered the expense of the workmanship of its construction. This relinquishment of the profit of trade does great credit to the ingenious and liberal-minded artists, Fraunhofer, and Utzschneider, the chief of the optical establishment at Munich.

3. Sir James South's Telescope.

Since the fabrication of the Dorpat telescope, an English astronomer, Sir James South, has been so fortunate as to procure, in France, an object-glass of even larger dimensions than that of the Dorpat instrument. The diameter is, we believe, about 12 inches, and the focal length 20 feet. The liberal proprietor has been for a considerable time past engaged in fitting it up, with the able assistance of the very ingenious artists Troughton and Simms, and has just finished an observatory for its reception. It will of course be immediately applied to the exploration of the heavens; and considering what Sir James South has done with instruments of much inferior power, we look forward with confident expectation to the extension of our knowledge of some of those sidereal systems which have so much engaged the attention of astronomers.

4. Professor Barlow's Telescope.

The Dorpat achromatic telescope, and the still larger and probably more powerful telescope which Sir James South is so happy as to possess, are of the ordinary construction. The great difficulty was to obtain pieces of flint glass of such a size as to form the object-glass. Notwithstanding the belief (we fear delusive) that this difficulty was overcome by the ingenuity of artists in Switzerland, and the hope entertained from the partial success of experiments in this country, the difficulty of obtaining plates of glass of a proper size does still, and may perhaps always exist. Taking this view, Professor Barlow of the Royal Military Academy at Woolwich turned his attention to a mode of construction, in which the use of flint glass, the great desideratum, might be dispensed with; and from what he has already done, we have no doubt whatever of his ultimate success. Upwards of forty years ago, Dr Blair attempted to improve the common construction of the achromatic telescope, by the introduction of a fluid into the combination of glasses which formed the object-glass; but Mr Barlow has proceeded in a different way: he placed an object-glass of plate glass (which without much difficulty may be obtained good of considerable magnitude) in the farther end of the telescope; and in order to correct the colour, he placed, about midway between the object-glass and its focus, a fluid lens, through which the rays pass, and are refracted to a focus, so as to produce a correct and colourless image.

A telescope thus constructed has two advantages. The fluid lens, which is the most difficult part of the construction, is reduced to one half, or less than one half, of the plate lens at the end of the tube; and, what may be considered as of still more importance, a telescope of this kind, of 10 or 12 feet in length, will be equivalent in its focal power to one of 16 or 20 feet of the ordinary construction. (See Mr Barlow's papers in the *London Phil. Trans.* for 1828-29-31.)

The fluid which has been selected is *sulphuret of carbon*. This has a refractive index about equal to that of the best flint glass, with a dispersive power more than double; it is perfectly colourless, beautifully transparent, and, although very expansible, possessing the same, or very nearly the same, optical properties, when hermetically sealed,

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Mr Barlow has actually constructed, and mounted in an observatory, a telescope with a clear aperture of 7·8 inches, which, before the introduction of Sir James South's telescope, exceeded by about an inch the largest in this country. Its tube is 11 feet, which, together with the eyepiece, makes the whole length 12 feet; but its effective focus is 18 feet, and it carries a power of 700 on the closest double stars in South's and Herschel's catalogue. The ingenious inventor of this valuable instrument read a paper to the Royal Society in December 1830, *On the performance of fluid refracting telescopes, and on the applicability of this principle of construction to very large instruments*. From what he stated in this paper, it appears, that although his telescope does not equal in power either Sir James South's 20-feet telescope, or the fine new reflecting telescope with a 20-inch speculum, constructed by Mr Herschel, yet it makes a nearer approach to them, we believe, than any other achromatic telescope now in Britain.

Finally, Mr Barlow declares that he is willing, with proper aid, to undertake the construction of a telescope of much greater dimensions: he suggests an aperture of 2 feet, and a length of 24 feet. We believe this is not one of the innumerable projects which commonly end in disappointment; and we hope that William IV., our present gracious king, to whom Mr Barlow's powers are well known, may give him such countenance and support as his father George III. afforded to the late Sir William Herschel.

5. Mr Rogers's Telescope.

The difficulty of procuring disks of flint glass of the requisite magnitude, for the object-glass of achromatic telescopes of the common construction, and their great expense when obtained, has induced an ingenious mathematician, Mr Alexander Rogers of Leith, to attempt a construction in which the flint glass part of the telescope is not required to be so large as that composed of the more easily procured material, plate glass. He proposes to interpose between a single object-glass, formed of plate glass, and its focus, a solid compound lens divested of refraction by the opposing powers of a convex of plate and a concave of flint glass, but possessing a dispersion equal to the difference of the dispersions of its component lenses. This construction appears also to possess the great advantage, that the perfection of the telescope does not require any very accurate knowledge of the refraction and dispersion of the kinds of glass employed, or any extreme coincidence of the foci and curvatures of the lenses with those proportions which theory requires, as the correction of the optical aberrations is completed by certain adjustments of the positions of the lenses. This construction is somewhat like Mr Barlow's; in both, the correction of colour is produced, not at the object-glass, but at a considerable distance from it, in a position where the cross section of the rays, by their convergence, has been diminished, and therefore where the interposed correcting lens admits of a like contraction in size, in comparison with the object-glass.

Mr Rogers has actually procured a telescope to be constructed on his principles: we have seen it compared with a common achromatic telescope of like dimensions, in looking at terrestrial objects, and it seemed to perform well. The proper test, however, of a telescope, is a double, triple, or quadruple star. In a telescope of moderate length the *comes* of the pole-star answers very well. Mr Barlow, with a telescope of his construction, having an aperture of three inches, could see this small star with a magnifying power of 46. We know that a most competent judge entertains a favourable opinion of Mr Rogers's construction;

Practical Astronomy. but unless a man has leisure, and can perform the most important manipulations himself, or else has ample means of paying skilful workmen, the invention or improvement of instruments is any thing but a profitable speculation to him. (For an account of Mr Rogers's telescope, see *Mem. Astr. Soc. Lond.* vol. iii. part 2.)

The account here given of Messrs Barlow and Rogers's telescopes is to be considered merely as a *notice*: we shall have occasion again to recur to them. We might have adverted to two powerful telescopes, one a 20-feet reflector, with an aperture of 18 inches, constructed by J. F. W. Herschel, Esq., and the other, also a reflector, with an equal aperture, but 25 feet in length, constructed by Mr John Ramage of Aberdeen; but after what has been said, it seems sufficient to refer for these to the *Mem. Astr. Soc. Lond.* vol. ii. part 2, where they are fully described.

6. Transit Instrument, Meridian Circle, and Astronomical Clock.

The primary problem in geography is to determine the exact position of any proposed point on the earth's surface in respect of the equator and some assumed meridian, as that of Greenwich or Paris; that is, to find its latitude and longitude. The corresponding problem in astronomy is to determine the position of every fixed star, and in general of any celestial phenomenon, in respect to the equinoctial circle in the heavens (or else the pole) and a circle passing through the pole and the intersection of the equinoctial and ecliptic; that is, to find its *declination* or polar distance, and its *right ascension* (chap. i. sect. i.). The former of these is found in great observatories by the *mural quadrant* or *mural circle*, and the latter by the *transit instrument* or *meridian circle*, and the clock.

The first transit instrument of which we have any account was that of Roemer, which he described in 1700. (*Miscel. Ber.* tom. iii.) Dr Halley placed a transit instrument in the Greenwich observatory in 1721. The axis was iron, and the telescope about five feet in length. This has been long laid aside, but we believe it has been preserved as a relic. Transit instruments of the present day are of two forms; one, the most common, is adapted to the determination of the right ascension only, the other to the determination of both right ascension and declination, either at once or by separate observations.

We have selected one of the most modern of the first kind for description. It is now in Sir James South's observatory at Kensington, and was constructed for him in 1820, by his friend Troughton, with all the care he could bestow on it; and, as far as the just proportions of its parts are concerned, he regarded it as his happiest production. The instrument, with its various parts, is represented in Plate XCVI. Figures 1 and 3 represent two views of it. EO is an achromatic telescope, of which E is the end next the eye; AA' is its axis of motion, with which the tube is closely united at their junction, so as to form but one body. The extremities of the axis rest in notches formed on two cheeks of metal at AA', which are firmly attached to the inner faces of two stone pillars PP'; and B, B', B'', B''', are four braces connecting the tube and axis. These are the parts of the instrument which, on inspection, immediately meet the eye. When adjusted, the axis of motion of the instrument is truly horizontal and perpendicular to the plane of the meridian, and the optical axis of the telescope is in the plane of the meridian; the object of the whole construction is to keep it precisely in that plane, whatever position be given to the telescope by turning on its axis.

The object-glass of the telescope is four inches in clear, and its focal length seven feet two inches. The body of the telescope and the axis are formed of conical

Practical Astronomy. tubes firmly united in a spherical centre-piece, on which their wider ends rest, and cover two thirds of its surface: thus the tube of the telescope is formed of two pieces, which taper towards its extremities, where their diameters are the same as that of the object-glass. The axis in like manner tapers equally towards its extremities.

The centre-piece is perforated in the direction of the telescope, and also in that of the axis; the width of the first opening being a little more than the radius of the object-glass, and that of the second just enough to allow the light of a lamp placed near the end of the axis to pass uninterruptedly to the centre illuminator. The ends of all the four cones, where they join the sphere, are strengthened by circular pieces of cast brass, which extend full four inches into the cones, and are fixed by solder and pins. They are turned concave in front, so as to fit the surface of the sphere into which they are rabbeted, and serve to keep the opposite branches of the axis and telescope straight and perpendicular to one another; and to these pieces are attached rings for the reception of the screws which bind the whole together. The four branches of the axis and telescope are solely united by *tension bars*. These pass through the sphere, six in the direction of the axis and four in that of the telescope. They are arranged at equal distances between corresponding parts, but so as neither to obstruct the rays of the object-glass nor the light of the lamp that falls on the illuminator. They screw into the rings of the brass pieces which enter the cones. The tension bars serve a most important purpose in giving stiffness and permanence of form to the instrument; and he that would imitate it, would do well to study Sir James South's description in the *Phil. Trans. R. S.* 1826. Fig. 3 is a section through the axis, and exhibits the six bars which bind together the cones of the axis, and also the places of the four which are perpendicular to them, and which connect the tubes of the telescope. Fig. 4 is a section through the telescope; the bars of the telescope are shown lengthwise, whilst those of the axis are perpendicular. In both figures the illuminator within the telescope is shown, in one the polished surface, and in the other the back of the plate. The illuminator crosses the tube of the telescope at an angle of 45° . This position requires that the opening in it, through which the light coming through the object-glass passes, should be an ellipse. The braces B, B', B'', B''', extending from the cones of the axis to those of the telescope, are attached to the former about two inches from the pivots, and to the latter about ten inches from the centre-piece. They exert but a very slight pressure, and might have been omitted in this instrument. They were added in imitation of the Greenwich transit, to which they are essentially necessary.

The apparatus for giving the telescope any required altitude is shown at the eye end in figures 1 and 2, but on a larger scale in fig. 5. It consists of two complete circles, six inches in diameter, firmly attached to the eye end of the telescope: each is provided with two opposite verniers, subdividing its divisions into minutes of a degree. The indices have clamps and slow moving screws, and microscopes are attached to the verniers; a spirit level is also attached to the index of each circle. The apparatus is adjusted by setting the index to the place of the star, and then, the telescope being moved round till the bubble of the level stands in the middle of its range, the star will traverse the field between the two horizontal wires. If two stars differ but little in right ascension, as Capella and Rigel, so as not to allow time for changing the index which was set to the altitude of that which came first, then the index of the other circle may be set to the altitude of the following star, and both observed. When the same object is to be observed by direct vision, and also by reflection, then one of the indices may be set

Practical Astronomy. to point the telescope to the direct place of the star, and the other to its reflected image.

Figures 7 and 8 exhibit the plates or side-pieces, and Ys in which the pivots of the axis rest. The plates, which are semicircular, are imbedded in the stone piers, and are firmly screwed to them. Figure 7 represents the eastern plate, in which the contrivance for placing the axis truly level is contained. This adjustment is made by a piece of which the upper end is formed into a Y, and which may be moved vertically, but not laterally. To raise or depress it gradually, there is a piece having a short cylindrical part in the middle; also a fine screw at its upper end, which works in the movable piece, and a coarse screw at its lower, which works in the fixed plates. The cylinder has holes by which it can be turned round by a capstan pin. By the ingenious contrivance of the two screws, the sliding piece is moved vertically, but slowly; for the space gone through is only the difference of the spaces through which it would have been pushed or drawn by each screw acting by itself. Fig. 8 shows the western plate. In this the Y piece admits only of a horizontal motion for the purpose of placing the instrument in the meridian. The adjustment is effected by two screws, which work in the opposite sides of the piece, and whose heads abut against the fixed plate. To produce motion, one of them must be screwed and the other unscrewed by equal quantities while the observer's eye is at the telescope; and to effect this the screws are connected by pinion work put in motion by a handle hanging down close to the inside of the western pier. (See fig. 1.)

Fig. 9 is a bird's-eye view of the head of one of the piers. This is meant to show the apparatus for relieving the pivots of the axis and the Ys from a great part of the weight which would otherwise bear on them. Immediately behind the adjustable Y piece, but rather broader, is a plain piece of brass having a Y cut in its upper end: a lever also is seen, one extremity of which passes into a hole made in this Y piece, while the other end carries a weight. The bar of the lever is expanded into a circle whose centre is about one third of the lever's length distant from the pivot of the axis. The circle admits the illuminating lantern. Two steel screws, with blunted, hard, and polished points, are inserted in the diameter at right angles to the direction of the lever: these rest on hardened and polished planes, which are let into the stone pier, and together form the fulcrum, in the manner of a balance. The weight is a short cylinder hooked on the end of the lever: it is hollow to receive small shot, introduced, as a counterpoise, to relieve, more or less at pleasure, the instrumental portion of the pivot, also the instrument Y piece, of weight.

Fig. 6 is a perspective view of the eye end of the telescope. In it a micrometer is shown, which moves a plate contiguous to that in which the five transit wires are inserted: one wire is contained in the movable plate, and is intended to facilitate the observation of the pole-star and others near it.

In fig. 1, on the eastern side of the telescope, a projecting finger-screw is seen. This gives motion to an apparatus within the tube of the telescope for regulating the quantity of light projected by the illuminator on the transit wires.

The Greenwich transit instrument, also the workmanship of Troughton, and one of his much-admired productions, was placed in that observatory in 1816. In its construction it is nearly the same as Sir James South's, but of different dimensions. The object-glass of the telescope is 5 inches in clear aperture, and the focal length 10 feet: its horizontal axis, including the pivots, is 3 feet 10 inches. The semicircles at the eye end of the telescope being insufficient to enable the observer to direct the instrument

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to the reflected image of a star, a divided circle, two feet in diameter, is attached to one end of the axis. The pivots, originally of hard bell-metal, having suffered an alteration of figure from constant use, were replaced in 1825 by others of hardened steel. There is no apparatus whereby an observer can give a small azimuthal motion to the instrument with his eye at the end of the telescope. The piers are the same which supported the transit which preceded this. They are two feet square, and were formerly 6 feet 2 inches high; but to adapt them to the present instrument their height was augmented one foot, by placing on their top a semicylindrical piece, which projects 3 inches over the old piers, and inwards, because the axis of the present instrument is six inches shorter than was that of the former.

There are seven fixed vertical wires in the focus of the telescope, and two horizontal ones. Each of the latter is placed about a minute and a half from the centre of the field, and between them a star passes during an observation: an interval of 18.3 seconds of time elapses while a star in the equator passes between each adjoining two vertical wires. Besides these, there is attached to the eye-piece a fine micrometer, which carries a single vertical wire through a large range. This serves various practical purposes, particularly in observing the pole-star, or a star very near it.

The Greenwich instrument has no plumb-line; the axis is adjusted by a fine ground spirit-level, which, when in use, stands above the axis, upon the pivots.

All transit instruments have a *meridian mark*, that is, a mark on some remote object, by which it may be ascertained at any time whether the instrument be truly in the meridian.

Transit or meridian circles are in their nature quite analogous to the instruments we have described; with, however, the important addition of a graduated circle of considerable dimensions as a principal part of their construction. The meridian circle which Troughton constructed for Mr Groombridge, but which afterwards passed into the hands of Sir James South, is a fine example of this kind of instrument. A figure and description of it may be seen in Dr Pearson's valuable work on Practical Astronomy. The observatories of Königsberg and Göttingen possess very fine meridian circles, constructed by the late Reichenbach of Munich.

A clock of the very best construction is an indispensable companion of the transit instrument. This may be regulated so as to show either mean solar or sidereal time, according to the principal objects in view, the one being always easily convertible into the other. The attention of ingenious men has been long directed to the construction of the astronomical clock; but on this subject we shall have occasion to treat fully elsewhere in our work.

The transit instruments here described are of the most expensive kind, and adapted to the higher efforts in the cultivation of astronomy; but there are also portable transits which travellers may use, and which may serve to determine true time. In all applications of the transits, the axis must be placed truly horizontal by means of the level; the line of collimation, that is, a line between the centre of the object-glass and the centre of the cross wires, must move in a great circle, or, which is the same thing, it must be perpendicular to the axis; and the vertical circle which it describes must be the meridian: these are the three principal adjustments. The *Nautical Almanac* gives the exact time when the sun or certain considerable stars pass the meridian. The observer gives the telescope such a position that the star must appear in the field of view in its passage. When it is seen, he notes the exact time, by the beat of the clock, when it crosses each wire. As there are always pairs of wires equally distant from the

middle wire, the instant of passing the middle wire and the middle instant between the times of passing any pair will be the same. The exact time of the passage is thus found, not only by the middle wire, but also by each pair equally distant from it.

As an example of an observation, the transit of the star α Aquilæ was observed to pass the wires of a small instrument at the following times, 12th September 1827.

	H.	M.	S.
1 wire.....	8	20	21
2.....	8	20	41.5
3.....	8	21	1
4.....	8	21	21.5
5.....	8	21	41
5)	105	6.0	
	21	1.2	

The middle interval between the first and fifth wire is 8^h. 20^m. 1^s., and between the second and fourth 8^h. 20^m. 1^s.5; one agreeing exactly, and the other differing half a second from the observed passage over the middle wire. The mean of the whole is 8^h. 21^m. 1^s.2, and is obtained by taking one fifth of the sum of all the observed times. It was found from the right ascension of the sun and star given in the *Almanac*, that the star passed the meridian that day at 8^h. 18^m. 7^s.9, hence it appeared that the clock was 2^m. 53^s.3 fast.

In observing the sun's transit, the time of the passage of the preceding and following limbs must be observed; and the middle instant is that of the passage of the sun's centre, or apparent noon. To this, the equation of time being applied, the result will be the time before, or after mean noon. As an example, the sun's transit was observed, July 25, 1827.

	☉ 1 Limb.			☉ 2 Limb.		
	H.	M.	S.	H.	M.	S.
1 wire.....	0	6	0.0.....	0	8	14.0
2.....	0	6	22.0.....	0	8	35.5
3.....	0	6	43.0.....	0	8	56.5
4.....	0	7	4.5.....	0	9	17.5
5.....	0	7	25.5.....	0	9	39.0
Mean...	0	6	43.0.....	0	8	56.5
☉ centre passed.....	7	49.7				
Eq. time.....	6	7.6				
	1	42.1				

Hence it appears that the clock must have been 1^m. 42^s. fast.

7. Mural Quadrants and Circle.

The Royal Observatory at Greenwich has two *mural quadrants*, each about eight feet radius; these are fixed on a massive structure of hewn-stone, in the form of a parallelopiped, one on each side, and hence their name. That whose telescope is directed towards the north is chiefly of iron, and was erected by Graham in 1725, for the lunar observations of Halley: it was, however, re-divided by Bird in 1753. The other, for the southern part of the meridian, is of brass, and was constructed by Bird, and placed in its position in 1750: with this Bradley and Maskelyne successively made their observations for forty-six years.

Experience has now shown that entire circles have a great advantage over quadrants; accordingly, the use of the Greenwich quadrants has been discontinued, and in their stead a *mural circle* six feet in diameter, constructed by Troughton, was placed in the observatory on 12th June 1812. A second *mural circle*, nearly a copy of the other, constructed by Thomas Jones (another eminent artist), was, in 1825, placed in the observatory, fronting the former, and at a distance of seven feet; and with these

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Practical Astronomy. two instruments simultaneous observations are daily made on the polar distances of the heavenly bodies. The stars are observed both directly, and by reflection from a surface of quicksilver; sometimes directly or by reflection with both instruments, and sometimes directly with the one and by reflection with the other.

Figs. 1 and 2 of Plate XCVII. give two views of Troughton's mural circle. In fig. 1 the circle is seen obliquely on the front or eastern face of the wall, with the greater part of its apparatus. The breadth of the wall from north to south is seven feet, its thickness from east to west four feet, and its height ten feet. It is formed of four stones laid one on another. The third stone has in its under side a semicircular groove, cut in its middle from west to east, six inches radius. The upper side of the second stone being worked level, forms the diameter of this semicircular *arch-hole*, and supports the axis work of the instrument at about five feet above the floor. The real centre of the instrument is about five inches higher. The nucleus of the Greenwich circle is an octagon of eight inches diameter at the corners; its depth is three inches, and a circular perforation of six inches and a half is made through its whole depth. The outward faces of the octagon, which are each three inches square, support eight of the circle's conical radii, to which they are screwed and steady-pinned. The other eight radii are fitted in closely, each one between two of the former, so that their lower ends come down on the corners of the octagon. The limb of the circle consists of two rings, the interior one having its plane parallel, and the exterior perpendicular, to the plane of the circle, so that, when united, their section will be represented by the letter T. The interior or flat ring has in the engraving the appearance of passing through clefts in the middle of the outer ends of the sixteen radii, which are there solid. The perpendicular ring is fitted close on the exterior edge of the other, to which it is screwed, and also to the ends of the conical radii. The cones are bound together at half the distance from the double ring to the centre, by a circle of interposed bracing bars. The circular aperture of the octagon is shut up by plates before and behind, which are fastened to the octagon by strong steel screws. The posterior plate has a large circular hole, and the anterior a smaller one, both truly wrought. Into these the axis of motion is fitted, and united to the octagon and circle by means of screws. The axis is a cone of brass nearly seven inches in diameter in front, but behind only half as much, and nearly four feet long; this works in a socket, which at each end receives it, and in which it fits with the greatest possible exactness. The two parts which fit the axis are soldered into a strong brass tube, larger than the tube of the axis, but nearly of the same shape. On the tube of the sockets in front is soldered a strong perforated plate or upright bearing piece, at right angles to the axis, which nearly fills the semicylindrical aperture in the wall; and at the remote end is soldered a short cylinder, the use of which will be explained. It is there that the adjustments for placing the circle in the meridian, and for levelling the axis, are performed. Two strong horizontal plates are fastened on the lower surface (which is flat) of the perforation through the wall, one before and the other behind. The bearing piece of the socket in front only rests upon the plate, but behind, the bearing cock and plate are screwed together. In front, the plate and bearing piece are connected by a conical piece of hardened steel, which is fixed under the middle of this piece, and fits nicely into a hole in the plate, but so as to revolve. At this end of the axis these parts do not come quite in contact; for there are fixed under the bearing piece, at each extremity, about ten inches apart, two short props, like buttons of hardened steel, the spherical

surfaces of which rest upon planes of hardened steel fixed in the plate. The central conical piece prevents the circle from sliding sideways when angular motion is given round this conical piece to bring the instrument into the plane of the meridian. It has been stated that a short cylinder was soldered on the remote end of the cone of the sockets. This passes into a perforation in the cock behind, which perforation is greater than that of the cylinder. Two fine threaded screws at right angles to each other work in the cock, one vertically for levelling, and the other horizontally for meridian adjustment. The two screws only press with their points against the sides of the short cylinder; but opposite to them are the ends of two small cylinders standing in the same line, which are urged forward with spiral springs, and thus force the short cylinders into contact with the screws. The telescope is seen on the face of the instrument; its focal length is six feet two inches, which is the exact outer diameter of the circle; the aperture is four inches, and its common magnifying power about 150. The telescope is attached to the circle at the centre by a steel axis, which passes through the proper axis of motion from end to end, and was indeed the arbor on which the axis was turned. The weight of the telescope is supported on its own axis, and it may be fixed to the circle in any position, by means of two clamps which keep hold of the border of the circle. The graduation of the instrument is on the convex cylindrical surface of the exterior ring, therefore the reading microscopes have their direction parallel to the plane of the instrument. The divisions on Troughton's circle are made on a narrow ring of white metal, composed of four parts gold to one of palladium; and the figures which count the degrees are engraved on a like ring of platina. In Jones's circle the divisions are on gold. None of these metals tarnishes in the least degree. The divisions are by lines, and suited to wires which cross in an acute angle in the reading microscopes. The degrees are cut into 5' spaces, and are numbered from the pole southward to the same pole again, viz. from 0° to 360°. The 5' spaces are subdivided by the microscopes to single seconds; and a division representing this quantity on the micrometer head may be easily estimated to the tenth of a second. There are six reading microscopes; but in general the two horizontal ones only are used.

In order that the circle may move easily round on its axis, there is an apparatus for counterpoising it, or for lifting the whole weight, without which the load would press altogether on the lower side of the front socket. This is effected by means of two large rollers, shown below the axis in fig. 1. The rollers, set in a double frame, act on the edge of the centre flanch, nearly in contact with the radial cones. Two perpendicular bars of steel, at about the height of the centre, are connected with the frame of the rollers by hook and eye; and these bars are in a similar manner suspended by two beams, each resembling a common balance, at the top of the wall. The part which appears in front is shown in fig. 1, and one of the beams, its fulcrum and counterpoising weight, near the top of the wall, in fig. 2. This apparatus produces a simple lift, without any tendency to affect the due motion of the circle's axis.

There is another flat, circular ring, somewhat larger than the graduated one, fastened at several places to the wall, and nearly touching it. On this ring the clamp and screw for slow motion slide, and may be clamped to it at any part of the ring.

The plumb-line of the mural circle, seen in fig. 2, is for placing the axis truly horizontal. The apparatus by which the plummet is suspended applies by dovetail fittings occasionally to the wall near its top, see fig. 1. The apparatus itself is shown in fig. 2. In fig. 1 fixed micro-

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scopes are seen on the telescope, near its end for viewing the plumb-line.

The wires of the telescope are illuminated by a diagonal reflecting plate in the middle of the tube, which receives the light by a circular aperture, seen in fig. 1, in a line with the centre of the circle. A lantern, at four or five feet distance, placed in the line of the axis, throws light on the field of view.

The instrument seen in a vertical position on the back of the wall is a zenith micrometer. It was erected to discover, if possible, the parallax of a star that passes very near the zenith; but it has never been used.

The mural circle has as an accompaniment a clock; and since all observations made with it require to be corrected for refraction, which depends on the state of the atmosphere (see table in page 100), every recorded observation must have annexed to it the height of the barometer and thermometer.

We have now described the instruments which constitute the principal furniture of an observatory, and which are all that the present state of the science absolutely requires. We proceed next to describe some others which are extremely convenient, and articles of luxury in the science.

8. Equatorial Instruments.

An equatorial instrument is of great value to a practical astronomer, for by means of it he can direct his telescope at once to any phenomenon, however minute, whose right ascension and declination are known; and reverse-ly, he can determine the right ascension and declination of any phenomenon to which it is directed, although out of the meridian. There is a fine instrument of this kind in the Greenwich observatory. It was made by Ramsden, for Sir George Shuckburgh.

Plates XCVIII. and XCIX. give a representation of Sir James South's five-feet equatorial instrument. The greater part of this instrument is composed of tinned iron plate; and its characteristics are lightness, steadiness, promptness in answering to its adjustments, and capability of retaining them. Fig. 1 of Plate XCVIII. represents the instrument as viewed at right angles to the declination circle. The polar axis is about $10\frac{1}{2}$ feet long; the lower end is a pivot attached to a cone, which, reckoning upwards, is about a fourth of the whole length. The higher side of the cone is cut in a sloping direction, as seen in the figure, for the purpose of more conveniently observing the vicinity of the pole. From the upper end of the cone the polar axis branches into two parts, between which is room for the declination circle and the head of the observer. These two branches are again united at the top by an open frame of bell metal, represented in fig. 2, to which the upper pivot is attached. This frame, as well as the iron-work which composes it, is so contrived as to present the least possible surface to obstruct the telescope; for the same reason the pivot at the top of the telescope is made as small as possible, whilst that at the lower end is considerably larger. Both ends of the axis are supported on stones, the northern end rising within about four inches of the level of the declination circle, the rest of the support being of wrought iron. At the southern end the stone rises very little above the floor, but a cast iron frame supports the pivot at the height of about two feet. The Y, or angle which supports the lower pivot, is placed upon the frame, and provided with two screw adjustments, one for giving the axis its due elevation, and the other for bringing the instrument to the meridian. The form of the iron-work will be understood by consulting the different figures. The two branches of the polar axis on their upper sides are formed of broad

planes, making one continued plane. On these the axis and reading microscopes of the declination circle are fixed. The instrument is self-balanced by the position and figure of its parts, and the addition of a weight fixed to the conical part of the polar axis. The diameter of the declination circle is four feet, the length of the telescope five feet, and of the axis about thirty-two inches. In Plate XCVIII. fig. 1, the declination circle appears quite plain, like the head of a drum, with the telescope directed towards the equator. In Plate XCIX. fig. 1, the polar axis is considerably fore-shortened, from the position of the draughtsman in making the drawing of the instrument. In this figure the edge of the declination circle is shown as a short cylinder, with the telescope protruding beyond it. In this figure, also, the shape of the declination axis, and the two principal microscopes for reading the declination, are shown. There is a third microscope, which indicates zenith distances. This is seen in Plate XCVIII. fig. 1, between the eye end of the telescope and the instrument's elevated pole. In the same figure is shown a narrow brass ring, whereon the graduation is made.

The hour-circle, two feet in diameter, is fastened to the lower end of the polar axis; its edge is seen in Plate XCVIII. fig. 1, and its under side in Plate XCIX. fig. 1 and fig. 3. One of the reading microscopes is well seen in fig. 1 of Plate XCVIII., and both of them less perfectly in the other two figures. The circle is of brass, and the divisions (fine lines) are on an inlaid ring of platina, corresponding to twenty seconds each; these are subdivided by the microscopes to tenths of seconds. The declination circle is divided to five minutes, which are subdivided by the micrometer screw of the microscopes to single seconds. The instrument is furnished with two ground levels. The divided side of the declination circle is quite flat; but the opposite face is articulated, showing how the parts are united. It is on this side that the levels would be seen; one of them is parallel to the telescope, and the other to the declination axis.

The clamps and screws for slow motion are unusual, but remarkably good. Instead of the common mode of clamping the circle, in this instrument the clamp is made to grasp the axis. There is soldered on each axis a ring of brass, the outer edge of which is broad and cylindrical. On this fixed ring a movable one is fitted, and afterwards cut into three equal parts: these are again united in two of the three sections by joints, like those which bind the different parts of a watch chain together. At the third juncture the clamping takes place, a projecting part of the ring having been there cut through, leaving one half on each side of the section. Here the ring gapes, but a screw passes through the projecting pieces or ears on each side of the disjunction, and, in bringing them together, grasps the axis with a firm embrace. To the middle of the tripartite rings are attached long arms of tinned iron plate, at the extremities of which the slow moving screws have their places. The fixed stud is in the lower screw, planted in the iron support; that of the upper one is in the polar axis. The long screw for slow motion in right ascension is acted on by a contrate wheel and a pinion at right angles to the plane of the circle, as shown in fig. 1, Plate XCVIII.; a long handle is attached to it, and shown leaning against the northern pier. A similar screw for declination, but without the contrate part, is seen in Plate XCIX. fig. 1.

The illumination of the wires of the telescope is made by a small lantern placed at one end of the declination axis; and there is a contrivance between the nozzle of the lantern and the end of the axis, by which the light is adapted to different observations.

The eye-piece of the telescope is represented in Plate XCIX. fig. 2, in which there is seen the edge of a gra-

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This instrument, when first constructed, was designed to be placed where a meridian mark could not be obtained. A mark, however, could be placed and seen to the westward; and to take advantage of this, the axis of the declination circle was converted into a telescope with two object-glasses of equal focus, two sets of cross wires, and an eye-glass that might be placed in either end; a mark was then built up to the level of the axis, and in a line at right angles with the meridian, and this formed a substitute for a meridian mark. The instrument bears no maker's name, but the scheme of its fabric was devised by the late Captain Huddart, F. R. S. The brass-work, &c. was made by J. and E. Troughton, under his direction; and the object-glass for the telescope of $3\frac{3}{4}$ inches aperture by P. and J. Dollond. To preserve the tinned work from oxidation, it is well covered with white paint, and varnished; thus it has not only a neat appearance, but can be easily cleaned at any time.

With this instrument, and another equatorial of seven-foot focal length, the object-glass being made by the late Tully, Sir James South and Mr J. F. W. Herschel made observations on the apparent distances and positions of 380 double stars; a labour which they have since greatly extended, to the no small advancement of this part of astronomy.

9. Azimuth and Altitude Circle.

An azimuth and altitude circle, called also an astronomical circle, is in itself a complete astronomical apparatus, when combined with a good clock or chronometer; for by means of it the latitude of the observatory may be found with great accuracy, and afterwards the declination or polar distance of any celestial phenomenon. It may be used also as a *transit*, and applied to the determination of right ascensions; and, when portable, it serves as a surveying instrument. The transit instrument and mural circle can only be applied to meridian observations; but the azimuth and altitude circle, like the equatorial instrument, may serve to determine the position of a star in any quarter of the heavens. To a traveller who wishes to avail himself of all opportunities of improving geography and astronomy, this instrument is of the greatest value; and it gives the cultivator of astronomy who happens to possess it the means of gratifying his taste in making all kinds of observations. It was with an instrument of this kind, constructed by Troughton, that the present astronomer royal, Mr Pond, made his valuable catalogue of the polar distances of 44 principal stars, deduced from 1452 observations, which detected the defects of the Greenwich mural quadrants, and established his fame as an astronomer. The observations were made at Westbury, and the instrument has hence acquired the name of the *Westbury circle*. Its fame recommended it to the Glasgow Astronomical Institution, who purchased it and placed it in an observatory; but this scientific project failed, and we regret to say that its funds were reduced to such a state as to induce the institution to accept of fifty pounds for the Westbury circle. It passed into the hands of an eminent English astronomer who knew its value, and who put it into complete repair, and reckoned it a great acquisition. He, however, was rich in other instruments, and was induced to part with it for (as we have heard) four or five hundred pounds.

Azimuth and altitude circles are of various sizes. Troughton has constructed many portable ones, with the vertical circle eighteen, and the horizontal fifteen, inches in diameter. Sir Thomas Brisbane has a fine instrument of this kind (by Troughton) in his observatory at Brisbane Castle; but it is not portable, the axis being fixed in a stone pier. Its vertical circle is two feet in diameter.

Practical Astronomy. The Astronomical Institution of Edinburgh last year (1830) placed an azimuth and altitude circle in the observatory on the Calton Hill. It is the workmanship of Troughton, and another most ingenious artist, Mr Simms, now associated with the veteran astronomical engineer. The pier on which it stands is a frustum of a cone, having for its base a square prism six feet ten inches in the side, and rising nine inches above the floor of the observatory. The part of the pier above the base is composed of eight stones, each of which is a frustum of a cone, and the whole height of the pier from the floor is nineteen and a half feet. The diameter of the circular section of the pier at the base is equal to the length of the side of the square on which it stands, and at the top it is about two feet. The instrument is represented as it stands on its pier under the dome of the observatory, and is composed of two principal parts, the azimuthal or horizontal circle, and the vertical circle with its telescope. By this last the altitude of any celestial object is taken, and by the former azimuthal angles are measured. The axis, which is not seen in the figure, is firmly attached by screws to the cross horizontal bar, or thick plate, which bears the upright pillars of brass that support the vertical circle; and it is also made fast to the centre of the azimuthal or horizontal circle. The stone pier is hollow to a certain extent downwards, and receives a brass conical socket, which passes also through the hexagonal stone on the top. The socket is suspended in the cavity, without touching it, by a projecting flanch at its open end, which is the base of the cone; and this is firmly screwed down to a flat brass ring fixed in the upper surface of the hexagonal stone, which is in fact a part of the instrument. The axis of the horizontal circle goes into the socket without touching its sides, and it rests with its lower end, a blunt steel point, in a corresponding steel cavity at the bottom; thus the socket bears the whole weight of the instrument.

The upper end of the axis is kept in its place by a right-angled hole, having two springs opposite the points of contact, which press it against its bearings, while it turns in contact with only four points, with a steady and easy motion. The bar in which the vertical axis is thus centred is acted on by two adjusting screws that are independent of each other, and stand at right angles the one to the other, by means of which the axis is adjusted to its true vertical direction, while the blunt point continues in its subjacent cup at the bottom of the socket. The frame to which this apparatus is attached is composed of an hexagonal central piece, from which six strong conical tubes of brass proceed, and these are screwed to as many bearing pieces or cocks, standing on and made fast to the hexagonal stone, as shown in the engraving.

The azimuthal circle is composed of ten smaller conical radial tubes, and a circular limb of two feet diameter, divided into spaces of $5'$ all round, and, being firmly attached to the vertical axis, turns round between the radiated frame and the upper face of the stone pedestal. Its divisions are read off to seconds by two microscopes, one of which is seen in the figure, the other is hid by the instrument. The circle has a slow motion, regulated by a screw with two milled heads, which may also be turned by a handle with a Hooke's joint, which is seen near one of the angles of the hexagonal stone. The screw acting in the outward end is a compound bar, that terminates in a ring on the axis of the circle. The ring is cut into three portions, which are again united by joints at two of the sections, leaving the third open and gaping. There are two ears on the ring, one at each side of this opening, through which a strong screw passes. By turning the screw the opening in the ring closes, and the three parts of which it is composed, by moving on the joints, embrace the axis firmly and clamp it; the axis may be released by the reversed

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motion of the screw. There is another compound frame, one half of which is seen to the right of the former. This carries the microscopes at its opposite ends. It surrounds the central part of the main frame of radial cones that carries the adjusting screws, and is fixed over the opposite zeros of the horizontal circle when the instrument is placed in the meridian.

The vertical circle is 3 feet in diameter, and is divided into spaces of 5'. Its horizontal axis is supported by the two strong vertical pillars that turn with the concealed vertical axis, and is composed of three strong tubes; the middle one being cylindrical, and the two end ones conical, admitting of the transmission of light like the axis of a transit instrument. The axis is two feet long; its pivots are of bell-metal, and rest in adjustable Ys similar to those of a transit instrument. The circle is composed of two limbs, connected with its axis by conical radii, each limb having its own, twelve in number. The limbs are united by bars crossing obliquely, like net-work, from the one to the other, as shown in the figure. The divided face is read by a pair of opposite microscopes, which are supported in a horizontal position by a bar turned up at the ends, and fixed to one of the upright pillars; and a revolving level, seventeen inches long, hangs constantly on this piece, and is seen in the figure. The telescope has an aperture of $3\frac{1}{2}$ inches, and a focal length of 51 inches. The clamp of the vertical circle is seen on the inside of one of the upright pillars: and this, by turning the milled head of a screw, closes on the opposite flat sides of a portion of the limb that is not divided, and holds it fast, but subject to the slow motion which is produced by a double-headed milled screw, or by a handle with a Hooke's joint, which fits upon the axis of the screw. The upright pillars, which are hollow, contain within them strong spiral springs; these, by pressing upwards, support a large portion of the weight of the circle, and thus relieve the Ys, which are supported by gibbet-pieces attached to the pillars, as shown in the engraving.

The axis of the vertical circle is placed exactly horizontal by means of a spirit level, which when used passes between the cones of the circle, and rests with its reversed Y feet on the pivots. But this level is not shown. A truly

vertical position is given to the axis of the instrument by means of a plumb-line suspended from an apparatus made fast to the upper end of the long tube, seen to the left of the farther upright pillar, to which it is made fast at two places. The tube is 4 feet 6 inches long, and this is about the length of the silver wire by which the plummet is suspended; the plummet is a perforated cylindrical vessel containing lead shot, and is suspended in water contained in a cylinder, which fixes on the bottom of the tube, and may be taken off. The weight of the plummet is just as much as the wire will bear out of the water without breaking. The upper end of the wire is fixed in the angular point of an adjustable bearing piece of metal, that is moved by screws acting at right angles to each other. A microscope enters horizontally the side of the long tube, and with this the plumb-line is viewed, and at the same time the image of a luminous disk, formed by a perforation through a minute circle of metal, placed in a circular surface of mother of pearl. This image will be exactly bisected by the plumb-line in every position, if the axis of the horizontal circle be truly vertical; otherwise the adjusting screws must be applied to the axis until the image remains bisected, while the instrument is turned completely round. There are seven fixed vertical and three horizontal wires in the focus of the telescope; and the eye-piece is made to slide to the right and left, so that the eye may view directly the image of a star all the way in its passage across the field of view.

In selecting instruments for description in the general article ASTRONOMY, we have chosen the principal, such as are used at this time for the extension of the science. There are others of secondary importance. These will be explained in their alphabetical place. See CIRCLE, COLLIMATOR, DYNAMETER, LEVEL, MICROMETER, OBSERVATORY, SECTOR, TELESCOPE, VERNIER, &c.

Writers professedly on Practical Astronomy are, Ludlam, *Astronomical Observations*, &c; Vince, *A Treatise on Practical Astronomy*; Pearson, *Introduction to Practical Astronomy*; Franceur, *Astronomie Pratique*. See also *Account of a Trigonometrical Survey of Britain*; *Base du Système Métrique*, par Delambre; *Recueil d'Observations Géodésiques*, &c. par MM. Biot et Arago; and in general all Collections of Astronomical Observations.

Latitude and Longitude of various Places where Astronomical Observations have been made.

Places.	Latitude.	Longitude.	Places.	Latitude.	Longitude.
	° ' "	H. M. S.		° ' "	H. M. S.
Abo Observatory.....	+ 60 27 0	— 1 29 10	Lisbon Observatory.....	+ 38 42 24	+ 0 36 16
Alexandria.....	+ 31 13 5	— 1 59 41	London (St Paul's).....	+ 51 30 49	+ 0 0 23
Altona Observatory.....	+ 53 32 51	— 0 39 50	Madras (Flag-staff).....	+ 13 5 0	— 5 21 28
Bagdad.....	+ 33 19 40	— 2 57 39	Madrid.....	+ 40 24 57	+ 0 15 9
Barcelona.....	+ 41 21 44	+ 0 8 40	Manheim Observatory.....	+ 49 29 18	— 0 33 52
Berlin Observatory.....	+ 52 31 45	— 0 53 34	Marseilles Observatory.....	+ 43 17 49	— 0 21 29
Brussels.....	+ 50 50 59	— 0 17 29	Milan Observatory.....	+ 45 28 2	— 0 36 46
Busheyheath Observatory.....	+ 51 37 44	+ 0 1 21	Montauban Observatory.....	+ 44 0 55	— 0 5 23
Calcutta.....	+ 22 34 15	— 5 53 44	Oxford Observatory.....	+ 51 45 39	+ 0 5 1
Cambridge Observatory.....	+ 52 12 43	— 0 0 30	Palermo Observatory.....	+ 38 6 44	— 0 53 28
Cape of Good Hope Observatory...	— 33 55 42	— 1 13 32	Paramatta Observatory.....	— 33 48 45	— 10 4 5
Coimbra.....	+ 40 12 30	+ 0 33 38	Paris Observatory.....	+ 48 50 14	— 0 9 21
Constantinople.....	+ 41 1 27	— 1 55 41	Pekin Observatory.....	+ 39 54 13	— 7 45 51
Copenhagen.....	+ 55 41 4	— 0 50 20	Petersburg.....	+ 59 56 23	— 2 1 15
Dantzic.....	+ 54 20 48	— 1 14 31	Philadelphia.....	+ 39 56 55	+ 5 0 46
Dorpat Observatory.....	+ 58 22 47	— 1 46 48	Quebec.....	+ 46 47 30	+ 4 44 39
Dublin Observatory.....	+ 53 23 13	+ 0 25 22	Quito.....	— 0 13 17	+ 5 15 0
Edinburgh Observatory.....	+ 55 57 17.5	0 12 43.6	Rome.....	+ 41 53 54	— 0 49 59
Florence.....	+ 43 46 41	— 0 45 3	Slough Observatory.....	+ 51 30 20	+ 0 2 24
Geneva Observatory.....	+ 46 12 0	— 0 24 38	Stockholm.....	+ 59 20 31	— 1 12 14
Gotha Observatory.....	+ 50 56 8	— 0 42 56	Tubingen Observatory.....	+ 48 31 10	— 0 36 14
Göttingen Observatory.....	+ 51 31 50	— 0 39 46	Turin.....	+ 45 4 0	— 0 30 41
Greenwich Observatory.....	+ 51 28 40	0 0 0	Uraniburg Observatory.....	+ 55 54 38	— 0 50 52
Kew Observatory.....	+ 51 28 37	+ 0 1 3	Verona Observatory.....	+ 45 26 7	— 0 44 5
Königsberg Observatory.....	+ 54 42 12	— 1 21 57	Vienna Observatory.....	+ 48 12 40	— 1 5 31
Lilienthal.....	+ 53 8 30	— 0 35 37	Viviers Observatory.....	+ 44 29 14	— 0 18 44

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Asturias.

ASTRUC, JOHN, a celebrated physician, was born in the year 1684, at the town of Sauves, in the province of Languedoc. His father, who was a Protestant clergyman, bestowed particular pains upon the earlier part of his education; after which he went to the university of Montpellier, where he took the degree of master of arts in the year 1700. He then began the study of medicine, and in two years obtained the degree of bachelor, having upon that occasion written a dissertation on the cause of fermentation, which he defended in a very spirited manner. On the 25th of January 1703 he was created doctor of physic; after which, before arriving at extensive practice, he applied to the study of medical authors, both ancient and modern, with uncommon assiduity. The good effects of this study soon appeared; for in the year 1710 he published a treatise concerning muscular motion, from which he acquired very high reputation. In the year 1717 he was appointed to teach medicine at Montpellier; which he did with such perspicuity and eloquence, that it was universally said he had been born to be a professor. His fame soon rose to such a height, that the king assigned him an annual salary; and he was, at the same time, appointed to superintend the mineral waters in the province of Languedoc. But as Montpellier did not afford sufficient scope for his aspiring genius, he went to Paris with a great stock of manuscripts, which he intended to publish, after subjecting them to the examination of the learned. Soon after, however, he left it, having in the year 1729 accepted the office of first physician to the king of Poland. In this capacity he remained only for a short time, and again returned to Paris. Upon the death of the celebrated Geoffroy, in the year 1731, he was appointed regius professor of medicine at Paris. The duties of this office he discharged in such a manner as to answer even the most sanguine expectations. He taught the practice of physic with so great applause, as to draw from other universities to that of Paris a great concourse of medical students, foreigners as well as natives of France. At the same time he was not more celebrated as a professor than a practitioner. And even at an advanced age he persevered with unwearied assiduity in that intense study which first raised his reputation. Hence it is that he has been enabled to transmit to posterity so many valuable monuments of his medical erudition. He died on the 15th of May 1766, in the 82d year of his age. The following are the titles of his principal works:—1. *Origine de la Peste*, 1721, 8vo. 2. *De la Contagion de la Peste*, 1724, 8vo. 3. *De Motu Musculari*, 1710, 12mo. 4. *Memoires pour servir à l'Histoire Naturelle de Languedoc*, 1737, 4to. 5. *De Morbis Venereis*, libri sex, 1736, 4to; afterwards enlarged to 2 vols. 4to, and translated into French by Jault, 4 vols. 12mo. 6. *Traité des Maladies des Femmes*, 1761–1765, 6 vols. 12mo. 7. *L'Art d'Accoucher réduit à ses principes*, 1766, 12mo. 8. *Theses de Phantasia*, &c. 9. *De Motûs Fermentativi Causa*, 1702, 12mo. 10. *Memoire sur la Digestion*, 1714, 8vo. 11. *Tractatus Pathologicus*, 1766, 8vo. Besides these, in 1759 he published *Traité des Tumeurs*, 2 vols. 12mo, and one or two treatises not connected with medicine, one with the singular title of *Conjectures sur les Memoires originaux qui ont servi à Moïse pour écrire la Genèse*, Paris, 1753, 12mo; and a *Dissertation on the Immateriality and Immortality of the Soul*, Paris, 1755.

ASTURIAS, one of the provinces of the Spanish monarchy, distinguished by the title of a principality, and under that name conferred on the heir apparent to the throne of Spain. It is bounded on the east by Biscay, on the south by Leon, on the west by Galicia, and on the north by the ocean. It was known to the Romans during

their empire in Spain by the name of the Ultramontane provinces, being surrounded on every side but the north, where the sea bounds it, by high mountains, which are passable with difficulty by horses, and nearly impassable by wheel carriages. Its surface extends to 308 square leagues, and its population, according to the census of 1803, amounted to 364,238 souls. Although it is the most populous of any of the larger divisions of Spain, it contains few cities or large towns. The inhabitants are mostly employed in the cultivation of the land, and in such manufactures as cultivators require. The face of the country is excessively irregular and mountainous; the higher elevations are not cultivated; and even in the valleys, which are irrigated by numberless streams, though there is abundant pasture for cattle, there is a great deficiency of corn. The flour of maize constitutes the principal food of all but the higher classes of inhabitants. Wheat is not much grown. The humidity weakens the plant; and though at first it appears to flourish, and looks well till it is in blossom, it scarcely ever forms grain. Rye grows better, and constitutes part of the food, especially when mixed with maize. Chesnuts, as in the other parts of Spain, form an important portion of the sustenance of the inhabitants. They are very abundant on the hills, and the nuts as well as the wood are very valuable products. Other kinds of timber are found in the mountains, well calculated for ship-building; and several medicinal plants, such as hellebore, valerian, angelica, and others, which form trifling branches of commerce. Cows and horses are reared in this province, and considerable numbers of them sent to Galicia, Leon, and the two Castiles. Vines, for want of due attention, do not flourish. Very little wine is made, and that little of bad quality; but to compensate for this deficiency, they have abundance of apples, and cider forms the common drink of the people. In some parts of the province there are very valuable mines of coal, which provide fuel to the inhabitants and to such trades as require considerable fires; and some of the coal has been transported to Cadiz, Carthagena, and other ports in the Mediterranean Sea. In the lower parts of the country, especially on the sea coast, at a distance from coal mines and forests, the inhabitants use turf or peat for firing. In the vicinity of the river Avila there are some mines of copper worked; and as fuel is plentiful, manufactories of copper utensils have been established, from whence some parts of Leon and Castile are supplied with furnaces, kettles, pots, and other similar articles. Besides these, there is a royal manufactory near Oviedo, where, in blast-furnaces, they cast cannon-balls, granades, bombs, and cannon of all calibres. These latter are sent to Pola to be bored, and then to Oviedo, where they are mounted. Some coarse cloths are made, but not sufficient to supply the inhabitants.

The mountains, which cover the whole province, gradually decline in height as they approach the ocean, along the border of which is a narrow stripe of the best and most populous portion of the principality. From the narrowness of this tract, it must be seen that the courses of all the rivers are necessarily short and rapid, and that they are very apt to overflow the country when the rains descend on the mountains. The principal river is the Nalon, which encircles the city of Oviedo, before which it receives the river Caudal, formed by the junction of two other rivers, the Pola de Leon and the Aller. After passing Oviedo, the rivers Trubia and Narcea contribute their streams, when, under the designation of the Pravia, it falls into the ocean. Along the whole extent of the coast of Asturias, a length of 130 miles, there is not one good port. The best is Ribadesella, where a large frigate may anchor; but its entrance is bad. Gijon will admit a

Asturias.

Astyages
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Asylum.

vessel drawing 16 or 17 feet water, and when within, she is sufficiently safe; but the entrance is very narrow and very dangerous. It is a remark which has been made with sufficient accuracy to entitle it to credit, that on the whole coast of Asturias the sea has been constantly gaining on the shore; and if it continues to encroach for the next 50 years as it has done for the last fifty, the town of Gijon will be deprived of its port. The principal city is Oviedo, containing 6000 inhabitants. It is the see of a bishop, and the seat of a superior tribunal of law. It has a university, a well-endowed hospital, and a lazaretto. The cathedral is a large Gothic pile, with a tower of uncommon height. It is surrounded with a beautiful walk. The climate is very healthy, and its markets well furnished with every necessary of life. Among other convents, that of the Benedictines deserves notice, as the residence and burial-place of Father Feijoo, whose writings do honour to Spain. At a league from the city are the warm baths of Caldas. The spring issues from a calcareous rock of secondary formation: it is much resorted to, being found highly beneficial in many diseases. Gijon, though not the capital, is larger than Oviedo, and, on account of its harbour, of more importance. It is honoured by having been the native place of Jovellanos, one of the wisest and best men that Spain has recently produced. He founded here the Asturian Institution, destined for the instruction of youth in mathematics, mineralogy, and navigation, which still continues to flourish. He also projected a road, now in progress, for wheel-carriages to Leon from Gijon. The cabildo of Oviedo has done honour to his fame, by erecting at the gate of their city, through which this road passes, a stone with an inscription to perpetuate the obligations his country owed to him. At 10 leagues to the east-south-east of Oviedo stands the collegial church and sanctuary of Covadonga, whose fame has been extended by the history of the period when the remains of the Goths were collected in the mountains of Asturias, and who first commenced that opposition to and defiance of the Moors which continued during seven centuries, till the whole of the peninsula was cleared of that enterprising, predatory, and oppressive race. The sea coasts, as well as the small rapid streams, abound with fish of various kinds, the latter especially with salmon and lampreys, which are sent to supply the markets of Madrid. The important events of the early history of this principality will be communicated in the general historical account of Spain.—*Historia Natural de Asturias*, por Don Mariano Lagasca; *Viage de Ponz*; *Geografia de Espana*, por Antillon.

ASTYAGES, son of Cyaxares, the last king of the Medes. He dreamed, that from the womb of his daughter Mandane, married to Cambyzes king of Persia, there sprung a vine that spread itself over all Asia. She being with child, he resolved upon the destruction of the infant when born, and commissioned Harpagus to execute his barbarous purpose, who, however, preserved the child, which was named Cyrus. Astyages long afterwards hearing that his inhuman plan had been thus frustrated, caused Harpagus to eat his own son. Harpagus called in Cyrus, who dethroned his grandfather, and thereby ended the monarchy of the Medes.

ASTYANAX, the only son of Hector and Andromache. After the taking of Troy he was thrown from the top of a tower by Ulysses's orders.

ASTYNOMI, in Grecian antiquity, magistrates in Athens, corresponding to the ædiles of the Romans: they were ten in number.

ASYLUM, a sanctuary or place of refuge where criminals shelter themselves from the hands of justice. The word is compounded of the privative particle *α*, and *συλαω*, *I hurt*; because no person could be taken out of an asylum

without sacrilege. The asyla of altars and temples were very ancient, and likewise those of tombs, statues, and other monuments of considerable personages. Thus, the temple of Diana at Ephesus was a refuge for debtors, the tomb of Theseus for slaves. Among the Romans, a celebrated asylum was opened by Romulus between the mounts Palatine and Capitoline, in order to people Rome, for all sorts of persons indiscriminately, fugitive slaves, debtors, and criminals of every kind. The Jews had their asyla, the most remarkable of which were the six cities of refuge, the temple, and the altar of burnt-offerings. It was customary among the heathens to allow refuge and impunity even to the vilest and most flagrant offenders; some out of superstition, and others for the sake of peopling their cities. We even read of asylums at Lyons and Vienne among the ancient Gauls; and there are some cities in Germany which still preserve the ancient right of asylum. Hence, on the medals of several ancient cities, particularly in Syria, we meet with the inscription *ΑΣΥΛΟΙ*, to which is added *ΕΠΑΙ*. This quality of asylum was given them, according to M. Spanheim, in regard to their temples, and to the gods revered by them. The emperors Honorius and Theodosius granting the like immunities to churches, the bishops and monks laid hold of a certain tract or territory, without which they fixed the bounds of the secular jurisdiction; and so well did they manage their privileges, that convents in a little time became next akin to fortresses, where the most notorious villains were in safety, and braved the power of the magistrate. These privileges were extended not only to the churches and churchyards, but also to the bishops' houses, whence the criminal could not be removed without a legal assurance of life, and an entire remission of the crime. The reason of the extension was, that they might not be obliged to live altogether in the churches, &c. where several of the occasions of life could not be decently performed. But at length these asyla or sanctuaries were also stripped of most of their immunities, because they served to make guilt and libertinage more bold and daring. In England, particularly, they were entirely abolished. See SANCTUARY.

ASSYMETRY, the want of proportion between the parts of any thing; being the contrary of *symmetry*. Or, it is the relation of two quantities which have no common measure, as between 1 and $\sqrt{2}$, or the side and diagonal of a square.

ASYMPTOTE, in *Geometry*, a line which continually approaches nearer to another, but, though continued infinitely, will never meet with it.

ASYNDETON, in *Grammar*, a figure which omits the conjunctions in a sentence. As in *veni, vidi, vici*, where *ET* is left out; or in that of Cicero concerning Catiline, *abiit, excessit, evasit, erupit*.

ATE, the goddess of mischief, in the Pagan theology. She was daughter of Jupiter, and cast down from heaven at the birth of Hercules. For Juno having deceived Jupiter, in causing Eurystheus to be born before Hercules, Jupiter expressed his resentment on Ate, as the author of that mischief, and threw her headlong from heaven to the earth, swearing she should never return thither again (Homer, *Il.* xix. 125). The name of this goddess comes from *αταω*, *noceo*, "to hurt."

ATEMPO GIUSTO, in *Music*, signifies to sing or play in an equal, true, and just time.

ATERGATIS, in *Mythology*, a goddess of the Syrians, supposed to be the mother of Semiramis. She was represented with the face and breasts of a woman, but the rest of her body resembled a fish. Vossius says the term signifies *without fish*, and conjectures that the votaries of this deity abstained from fish.

Assymetry
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Atergatis.

Ateste
||
St Atha-
nasius.

Athanati
||
Athenæum.

ATESTE, a town in Austrian Lombardy, in Italy, now called Este. Long. 12. 6. E. Lat. 45. 25. N.

ATH, or AETH, a city of the circle of Tournay and province of Hennegau, in the kingdom of the Netherlands. It is situated on the river Dender, is well built and strongly fortified, has a new arsenal, with several bomb-proof magazines, and, exclusive of the garrison, contained in 1817 a population of 8296 inhabitants, who are very industrious, and employed in refining sugar and salt, in making soap, beer, and gin, and in the linen manufactory. It is 25 miles from Brussels. Long. 3. 44. 6. E. Lat. 50. 42. 17. N.

ATHANASIAN CREED, a formulary or confession of faith, long supposed to have been drawn up by Athanasius, bishop of Alexandria, in the fourth century, to justify himself against the calumnies of his Arian enemies. But it is now generally allowed among the learned not to have been his. Dr Waterland ascribes it to Hilary, bishop of Arles, for the following among other reasons:—1. Because Honoratus of Marseilles, the writer of his life, tells us that he composed an *Exposition of the Creed*; a more proper title for the *Athanasian* than that of *Creed* simply, which it now bears. 2. Hilary was a great admirer and follower of St Austin; and the whole composition of this creed is in a manner upon St Austin's plan, both with respect to the Trinity and incarnation. 3. It is agreeable to the style of Hilary, as far as we can judge from the little that is left of his works. Upon the whole he concludes, that Hilary, bishop of Arles, about the year 430 composed the *Exposition of Faith*, which now bears the name of the *Athanasian Creed*, for the use of the Gallican clergy, and particularly those of the diocese of Arles; that, about the year 570, it became famous enough to be commented upon; but that all this while, and for several years longer, it had not yet acquired the name of *Athanasian*, but was simply styled *The Catholic Faith*; that before 679 Athanasius's admired name came in to recommend and adorn it, being in itself an excellent system of the Athanasian principles of the Trinity and incarnation, in opposition chiefly to the Arians, Macedonians, and Apollinarians. Such is the hypothesis of the learned author of the *Critical History of the Athanasian Creed*. As to the reception of this creed in the Christian churches, we find that it obtained in France in the time of Hincmar, or about 850; that it was received in Spain about 100 years later than in France, and in Germany much about the same time. As to our own country, we have clear and positive proofs of this creed being sung alternately in our churches in the 10th century. It was in common use in some parts of Italy, particularly in the diocese of Verona, about the year 960, and was received at Rome about the year 1014. As to the Greek and oriental churches, it has been questioned whether any of them ever received this creed at all; though some very considerable writers are of a contrary persuasion. It appears, then, that the reception of this creed has been both general and ancient, and it may vie with any, in that respect, except the Nicene or Constantinopolitan, the only general creed common to all the churches. As to its matter, it is given as a summary of the true orthodox faith, and a condemnation of all heresies ancient and modern. Unhappily, however, it has proved a fruitful source of unprofitable controversy and unchristian animosity.

ATHANASIUS, St, bishop of Alexandria, and one of the greatest defenders of the faith against the Arians, was born in Egypt. He followed St Alexander to the council of Nice in 325, where he disputed against Arius, and the following year was made bishop of Alexandria, but in 335 was deposed by the council of Tyre; when, having recourse

to the emperor Constantine, the Arian deputies accused him of having hindered the exportation of corn from Alexandria to Constantinople; on which the emperor, without suffering him to make his defence, banished him to Treves. The emperor, two years after, gave orders that he should be restored to his bishopric; but, on his return to Alexandria, his enemies brought fresh accusations against him, and chose Gregory of Cappadocia to his see, which obliged Athanasius to go to Rome to reclaim it of Pope Julius. He was there declared innocent, in a council held in 342, and in that of Sardica in 347; and two years after was restored to his see by order of the emperor Constans; but after the death of that prince he was again banished by the emperor Constantius, which obliged him to retire into the deserts. The Arians then elected one George in his room, who being killed in a popular sedition under Julian in 360, St Athanasius returned to Alexandria, but was again banished under Julian. His successor Jovian, however, being a Christian, restored him to his see. To that emperor he addressed a letter, in which he proposed that the Nicene creed should be the standard of the orthodox faith, and condemned those who denied the divinity of the Holy Ghost. He was afterwards banished by Valens in 367, but again returned from what has been termed his fifth exile. St Athanasius died on the 2d of May 375. His works principally contain a defence of the mysteries of the Trinity, and of the incarnation and divinity of the Word and Holy Spirit. There are three editions of them which are esteemed; that of Commelin, printed in 1600; that of Peter Nannius, in 1627; and that of Father Montfaucon. As to the creed which bears his name, see the preceding article.

ATHANATI, in *Persian Antiquity*, a body of cavalry, consisting of 10,000 men, always complete. They were called *athanati* (a word originally Greek, and signifying *immortal*), because, when one of them happened to die, another was immediately appointed to succeed him.

ATHEIST, a person who does not believe the existence of a Deity. Many, both ancient and modern, have pretended to atheism, or have been reckoned atheists by the world; but it may be justly questioned whether any man ever seriously adopted such a principle. Among us, the greatest philosophers have been the principal advocates for the existence of a Deity. So true is the saying of Lord Bacon, that though a smattering of philosophy may lead a man into atheism, a deep draught will certainly bring him back again to the belief of a God and Providence.

ATHELING, ADELING, EDELING, ETHLING, or ETHELING, among the Anglo-Saxons, was a title of honour, properly belonging to the heir-apparent or presumptive to the crown. This honourable appellation was first conferred by King Edward the Confessor on Edgar, to whom he was great uncle, when, being without any issue of his own, he intended to make him his heir.

ATHELSTAN, a Saxon king of England, natural son of Edward the Elder, and grandson of the great Alfred. He succeeded to the crown in 925, and reigned 16 years. There was a remarkable law passed by this prince, which shows his just sentiments of the advantages of commerce, as well as the early attention to it in this country. It declared, that any merchant who made three voyages on his own account beyond the British channel or narrow seas, should be entitled to the privilege of a thane or gentleman.

ATHENÆUM, in *Antiquity*, a public place wherein the professors of the liberal arts held their assemblies, the rhetoricians declaimed, and the poets rehearsed their performances. The three most celebrated Athenæa were those at Athens, at Rome, and at Lyons; the second of which was built by the emperor Adrian.

Athenæus
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Athens.

ATHENÆUS, a Greek grammarian, born at Naucratis in Egypt in the third century, one of the most learned men of his time. Of all his works we have none extant but his *Deipnosophi*, i. e. the Sophists at Table. There is an infinity of facts and quotations in this work, without which we should have been ignorant of many curious circumstances regarding the ancients. The first edition was printed by Aldus in 1514, in folio. The best edition is that by Schweighæusen, published in 1801-7, in 14 vols. 8vo. There is a French translation of Athenæus, in 5 vols. 4to.

ATHENAGORAS, an Athenian philosopher, flourished about the middle of the second century, and was remarkable for his zeal for Christianity, and his great learning, as appears from the apology which he addressed to the

emperors Marcus Aurelius Antoninus and Lucius Commodus.

ATHENODORUS, a famous Stoic philosopher, born at Tarsus, went to the court of Augustus, and was made by him tutor to Tiberius. Augustus had a great esteem for him, and found him by experience a man of virtue and probity. He used to speak very freely to the emperor, and before he left the court to return home, warned him against giving way to anger, but whenever he should be in a passion, to rehearse the 24 letters of the alphabet before he resolved to say or do any thing. He did not live to see his bad success in the education of Tiberius.

ATHENREE, a town of Ireland, in the county of Galway, and province of Connaught. Long. 8. 5. W. Lat. 53. 14. N.

Atheno-
dorus
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Athens.

ATHENS,

"The eye of Greece" (to use Byron's phrase), the capital of Attica, and the birthplace of the most distinguished orators, philosophers, statesmen, historians, and artists of antiquity, is situated in long. 23. 24. E. lat. 38. 32. N., at the western extremity of the ancient territory of Attica, about 100 miles north-east of Misitra (Sparta), and above 300 miles south-west of Constantinople. See ATTICA.

By whom
founded.

The origin of Athens, like that of most other ancient and renowned cities, is involved in the obscurity of fable. Its reputed founder was Cecrops, an Egyptian, who brought from Sais the worship of the goddess Neith, called by the Athenians *Αθηνη*, and who, in the opinion of the learned, was contemporary with Moses. The new city was built on the rock of the Acropolis, which originally contained all the habitations of the Athenians, and received from Cecrops the name of Cecropia. But in the time of Erechtheus the First, called by later writers Erichthonius, the second of the early kings in succession from Cecrops, and the person who instituted the festivals called *Athenæa*, in honour of *Αθηνη* or Minerva, it lost the name which it had derived from its founder, and acquired that of *Αθηναι*, *Athens*, from the goddess to whose worship it was principally dedicated.

Ancient
state.

We have received little or no information respecting the size or dimensions of Athens under its earliest kings.¹ It is generally supposed, however, that even as late as the time of Theseus the town was almost entirely confined to the Acropolis and the adjoining hill of Mars. But during the six or seven centuries which elapsed between the Trojan war and the reign of Peisistratus, it appears to have increased considerably both in extent and population;² while the administration of that enlightened and patriotic usurper, so far from proving an impediment to the prosperity of the city, operated in aid of its improvement; as has often happened when power chances to fall into the hands of a person of taste and magnificence. By establishing a public

library, and by editing the works of Homer, Peisistratus and his sons fixed the muses at Athens. Nor, in the midst of all this attention to the cultivation of the arts and the embellishment of the city, had the means of defence against external aggression been neglected. For, since Athens was able to withstand a siege by the Lacedæmonians, during the reign of Hippias, one of the sons of Peisistratus, we may conclude that it already possessed walls and fortifications of sufficient height and strength to ensure its safety.

But the invasion of Xerxes, and the subsequent irruption of Mardonius, effected the entire destruction of the ancient city, and reduced it to a heap of ruins; with the exception only of such temples and buildings as, from the solidity of their structure, were enabled to resist the action of fire and the work of demolition. During their temporary ascendancy in Greece, the Persians displayed the same iconoclastic fury which had marked their career of conquest in Egypt with havoc and desolation. But when the battles of Marathon, Salamis, Plateæ, and Mycale, had dissipated the forces of the invader, and liberated Greece from the danger of subjugation to a foreign power, Athens, restored to peace and security, soon rose out of its ruins with increased splendour; and having been provided by Themistocles with the military works necessary for its defence, it attained, under the subsequent administrations of Cimon and Pericles, to the highest pitch of beauty, strength, and magnificence. The former, indeed, is known to have erected the temple of Theseus, the Dionysiac Theatre, the Stoæ, and the Gymnasium, and also to have embellished the Academy, the Agora, and other parts of the city, at his own expense;³ while the latter completed the fortifications which had been left in an unfinished state by Themistocles and Cimon—rebuilt several edifices which the Persians had destroyed—and, above all, immortalized himself by the construction of the temple of

Effects of
the Persian
invasion.

¹ The principal works on the topography of Athens, which has been discussed at length, and with great accuracy and research, by modern antiquaries and travellers, are Stuart's *Antiquities of Athens*; Dodwell's *Classical Tour*, vol. i.; Mr Hawkins' *Dissertation on the Topography of Athens* in Walpole's *Memoirs*, vol. i. p. 480; Colonel Leake's *Topography of Athens, with some Remarks on its Antiquities*; and Mr Cramer's *Geographical and Historical Description of Ancient Greece*, vol. ii. p. 309. These writers, with the exception of Mr Cramer, have in general followed Pausanias, who, having himself visited Athens, describes, in his first book, its antiquities and most remarkable edifices. But as it is admitted on all hands that Pausanias has neglected to notice several important buildings pointed out by other authors, and that his description is, besides, defective in several particulars, we have availed ourselves of the additional information supplied by Meursius in his *Athenæ Atticæ*, and by succeeding antiquaries, in order that we might be enabled to form as accurate a list as possible of the principal edifices and monuments of this celebrated city.

² This must have been true even in the time of Homer, who applies to it the epithets of *εὐκτιμένης* and *εὐαυγυμνός*, which seem to indicate a place of some consideration.

³ Plutarch in *Vit. Cimon*.

Athens. Eleusis, the Parthenon, and the Propylæa, edifices alike unrivalled for classical purity of design and perfection of execution.

Age of Pericles; population. It was, indeed, under the administration of Pericles that Athens attained to that eminence in art which has excited the wonder and admiration of all succeeding ages: it was to this illustrious man that the city was principally indebted for the splendour of its architectural decorations, and the republic for its prosperity and its power. At the period in question the whole of Athens, with its three ports of Peiræus, Munychia, and Phalerum, connected by means of the celebrated Long Walls, formed one great city, inclosed within a vast peribolus of massive fortifications, extending to not less than 174 stadia, of which the circuit of the city amounted to 43, the long walls taken together to 75, and the circumference of the three harbours to 56.¹ There is some difficulty in ascertaining the amount of the population of Athens at this period. Xenophon informs us that it contained more than 10,000 houses, which, at the rate of ten persons to a house, would give 100,000 souls for the whole population of the city. By a census of Pericles, mentioned by Plutarch in his life of that statesman, it, however, appears that the number of Athenians entitled to exercise the rights of citizenship was confined to 14,040; and at no subsequent period does this number appear to have much exceeded 20,000, which indeed may be taken as the average amount of the free adult male population of Athens, enjoying the rights of citizenship. See ATTICA.

Dimensions of the walls. From the researches of Colonel Leake and Mr Hawkins, it appears that the ancient city considerably exceeded in extent the modern town; for, although the scanty remains of the old fortifications are insufficient to enable us to judge of their circumference, it is nevertheless evident, from the measurement furnished by Thucydides, that they inclosed a much larger space than that contained within the present line of wall, particularly towards the north. It is probable, indeed, that, on this side, the extremity of the city reached as far as the foot of Mount Anchesmus; and that, to the westward, its walls followed the course of the small brook which terminates in the marshy ground of the Academy, until they met the point where some of the ancient foundations are still to be seen near the Dipylum; while, to the eastward, they approached close to the Ilissus, a little below the present church of the Mologitades or Confessors. The entire peribolus of the fortifications, including the walls of the city, the longimural inclosure, and the defences of the ports, cannot therefore have been less than nineteen miles; but from the extreme irregularity of the space inclosed, it is impossible to form any accurate estimate of its dimensions. Ancient writers inform us, however, that Athens was nearly equal in extent to Rome within the walls of Servius; and Plutarch compares it in point of size to Syracuse, which Strabo estimates at 180 stadia, or upwards of 22 miles in circumference.

Gates, Dipylum, &c. The number of gates in the fortifications of ancient Athens is uncertain; but the names of nine have been preserved by the classical writers. These are Dipylum (otherwise called Thriasîæ, Sacræ, or Ceramicæ), Diomeiæ, Diocharis, Melitides, Peiraicæ, Acharnicæ, Itoniæ, Hippades, and Heriææ. The Dipylum was situated in that part of the wall which separated the inner from the outer Ceramicus, and formed the communication between them;

Athens. from which circumstance it was sometimes called the gate of Ceramicus. It seems also to have been occasionally named the Sacred Gate, from its leading into the Sacred Way; and the Thriasian gate, or gate of Thria, from its conducting to or forming the outlet in the direction of Eleusis and Megara. On the north-west side of the Acropolis, in a hollow adjoining a small church built on a rock and dedicated to St Athanasius, there still remain some appearances of the foundations of a gate; and here, accordingly, Colonel Leake and others have fixed the site of Dipylum. The Diomeiæ, probably so called from Diomeia, one of the Attic demi, which itself received its name from the hero Diomus, was nearly opposite the entrance of the suburban gymnasium called Cynosarges, a place dedicated to Hercules, and situated to the north-east of Athens. The gate of Diocharis fronted the entrance of the Lyceium, near to the fountain of Panops; while that called Melitides was situated in the southern part of the wall, towards the sea and Phalerum; and the Peiraicæ, as its name sufficiently implies, led to the harbour of the Peiræus. Traces still exist of the Melitides and Peiraicæ, as well as of the Dipylum. There can be little doubt that the gate called Acharnicæ was so named from its leading to the demus of Acharnæ, the situation of which was probably at or near the modern village of Menidhi, close by the spot where the present road to that village intersects the line of the ancient walls. The site of the Itonian gate, mentioned in the dialogue of Axiochus, is placed by Colonel Leake about half-way between the Ilissus and the foot of the hill of Museum, where the road leading direct to Phalerum from the modern Inté-kapesi or Albanian gate cuts the line of the ancient walls. Of the Hippades we only know that it was the gate on the outside of which was the sepulchre of the family of the orator Hyperides. It seems to have derived its name from some equestrian statues erected near it; and it is not improbable that the Hippades may have been the gate between Dipylum and the Peiraic, of which some vestiges still exist on the north side of Mount Lycabettus. Lastly, the Heriæ or Heriææ was so called from its being the gate through which corpses were usually conveyed to the burying-ground, but its precise site cannot now be discovered. Athens, in fact, was surrounded on every side with an immense cemetery. On the north-west and north, from the northern long wall to Mount Anchesmus, there was a continued succession of sepulchres; and the excavations made in search of sepulchral antiquities have proved that there were similar burying-grounds on the outside of the southern long wall.²

Pausanias commences his description of Athens apparently from the Peiraic gate. We shall imitate his example, and follow nearly the same course; supplying his omissions as we go along, and conjoining with our accounts of ancient edifices and monuments notices of their existing state and condition where any traces or vestiges of them still remain. On entering the city, the first building remarked by Pausanias was the Pompeium. This was so called from its being the depository of the sacred vessels (πομπεια) used in certain processions, which, being of great value, had a separate building appropriated for their safe custody. In the Pompeium there was also a statue of Socrates by Lysippus, together with several portraits of eminent individuals, amongst which that of Isocrates has

¹ Taking the itinerary stadium at 575 English feet, or the length resulting from the equation of 19 English miles with 174.5 stadia, it would of course follow that the peribolus of fortifications was just the same number of miles in extent. But it has been ascertained that the Greek stadium in the time of the Roman emperors exceeded the itinerary stadium by 30 feet, or, in other words, was equal to 605 English feet; which, taken as the true value of the measure, would consequently give $605 \times 174 \div 5280 = 20.036$ miles as the entire circumference. (Leake's *Topography*, p. 369.)

² Leake's *Topography of Athens*, p. 374, 375.

Athens. been particularly mentioned. Near this edifice stood a temple of Ceres, containing statues of that goddess, of her daughter Proserpine, and of Inachus, executed by Praxiteles; and beyond it were several porticoes leading from the city gates to the outer Ceramicus; while the intervening space was occupied by some temples, the Gymnasium of Mercury, and the house of Polytion, where some Athenians of distinction (probably Alcibiades and his companions) are said to have celebrated mysteries similar to those of Eleusis.¹

Ceramicus. There were two places in Athens known by the name of Ceramicus;² one without the walls, forming part of the suburbs; and the other within, including a considerable and very important section of the city. The outer Ceramicus was covered with the sepulchres of the Athenians who had been slain in battle, and buried at the public expense, with the exception of those who fell at Marathon, and who were interred on the spot where they had died so gloriously; and it appears to have communicated with the inner Ceramicus by means of the gate Dipylum, which is understood to be the Ceramic entrance alluded to by Philostratus. The Ceramicus *intra muros* probably included the Agora, the Stoa Basileus, and the Poecile, besides various other temples and public buildings. Antiquaries, it is true, are not decided as to the general extent and direction of this portion of the ancient city; but, from the researches and observations of Colonel Leake, it seems pretty certain that it lay entirely on the south side of the Acropolis,³ where it was of course bounded by the city walls, which ran close to the fountain Callirrhoe, or Enneacrunus; and that, consequently, its breadth could not have exceeded one half of its length.⁴ We shall now give some account of the edifices in this part of the ancient city, reserving what we have to say of the outer Ceramicus until we come to describe the suburbs.

Ceramic edifices. The first building mentioned by Pausanias is the Stoa Basileus, so called because the archon Basileus held his court there, and which probably stood at the western extremity of the Areiopagus. Its roof was adorned with statues of baked clay; and adjoining it were statues of Cimon, and Evagoras, king of Cyprus. Behind this portico was another, containing paintings of the twelve gods, and of Theseus and "the fierce democracy,"—thus implying that he was the first to establish equal rights among the citizens of Athens; together with a picture by Euphranor, representing the achievements of the Athenian auxiliary cavalry at the battle of Mantinea. The temple of Apollo Patrons was situated in the vicinity of the latter portico, and was dedicated to that god in his capacity of *Alexica-cus*, on the supposition that he had put an end to the pestilence which desolated Athens during the Peloponnesian war. The Metroum, a temple consecrated to the mother of the gods, was the grand depository of the archives of the state, and served also as a tribunal for the archon eponymus. Adjacent to the Metroum was the senate-house (*βουλευτήριον*), containing statues of Jupiter the Counsellor, of Apollo, and of the Athenian demus; and close to the council-wall stood the Tholus, where the Prytanes usually held their feasts and sacrifices; while somewhat higher up were the statues of the eponymi, or heroes, who gave

names to the Athenian tribes, with those of Amphiarus, Lycurgus the orator, and Demosthenes. Near the latter stood a temple of Mars, having several statues within, and around it those of Hercules, Theseus, and Pindar, who was thus honoured for the praise he had bestowed upon the Athenians; close to which were the figures of Harmodius and Aristogeiton. All the statues here mentioned were carried away by Xerxes when he plundered Athens, but were afterwards restored by Antiochus, as we learn both from Pausanias and from Arrian. Above the Stoa Basileus was a temple of Vulcan, and also one dedicated to Venus Urania, containing a statue of the goddess in Parian marble, executed by the chisel of Phidias; both of which edifices were situated near the western extremity of the hill or ridge of Areiopagus.⁵

One of the most important of the Ceramic edifices was Stoa Poecile, so called from the celebrated paintings cile. with which it was adorned, although its more ancient name appears to have been Peisianactius. The paintings were almost exclusively devoted to the representation of national subjects, as the contest of Theseus with the Amazons, the battle of Marathon, and other achievements of the Athenians; and were mostly executed by Polygnotus, Micon, and Pamphilus, the most celebrated amongst the early Grecian artists. Here were also suspended the shields of the Scionæans of Thrace, together with those of the Lacedæmonians taken in the island of Sphacteria; and it was in this portico that Zeno first opened that celebrated school, which thence received the appellation of Stoic, and was destined to exercise a most powerful influence both on the philosophy and legislation of succeeding times. The Poecile is also memorable as the scene where no less than fifteen hundred citizens of Athens are said to have been destroyed by the Thirty Tyrants. Some ancient walls which are still extant near the church of Panagia Fanaromeni, Colonel Leake supposes, with some probability, to be the remains of this once celebrated portico. Near the Stoa Poecile was a statue of Hermes Agoræus, which, from its position close to a small gate, was sometimes termed *Ἑρμῆς πρὸς τὴν πόλιν*.⁶

The epithet Agoræus naturally leads us to conclude Ceramic that this brazen figure of the god, described by the Roman satirist as *furum aviumque maxima formido*, stood in the ancient Agora or market-place, by much the largest portion of which was in the quarter of Ceramicus. Xenophon also informs us, that, at certain festivals, it was customary for the knights to make the circuit of the Agora on horseback, beginning at the statue of Hermes just mentioned, and paying homage as they passed along to the statues and temples around it.⁷ There is sufficient reason to believe, however, that the ancient Agora never extended to the southward and eastward of the ascent to the Acropolis; but it seems to have included a very large space to the west and north-west of the Propylæa; which is accounted for upon the supposition, which a number of circumstances conspire to render probable, that the market-place, or at least its most frequented parts, had shifted their position at different periods of the republic. In the more remote ages, when the Acropolis or Cecropia was almost the only inhabited part of the site of Athens, it is natural

¹ Demosthenes in *Phorm.*; Diogenes Laertius in *Vit. Socrat.*; Plutarch in *Vit. Alcibiad.*; and Thucydides, vi. 27.

² So called either from the hero Ceramus, or from potteries which were formerly situated in the neighbourhood. Herod. v. 88; Suid. v. Κεραμυς.

³ Leake's *Topography of Athens*, p. 101.

⁴ Schol. Aristoph. *Equit.* 772; Plutarch, *Syll. Κεραμυς*; Hesychius, v. Κεραμικος.

⁵ Pausanias, *Attic.* 3; Plutarch *de Glor. Athen.*; Pliny, xxxv. 11; Harpocrates, v. Μνητεριον; Suidas, v. Αγορα and Θεολος; Pausan. *Attic.* 8; Arrian *de Exped. Alex.* iii. 16.

⁶ Diogenes Laertius in *Vit. Zenonis*; Plutarch in *Vit. Cimonis*; Pausan. *Attic.* 15; *Ælian, Hist. An.* vii. 28; *Æschines de Fals. Leg.*; *Topography of Athens*, 118; *Description of Ancient Greece*, ii. 319.

⁷ Xenophon, *Hipparch.* c. 3.

Athens. to believe that the Agora resorted to from the neighbouring country must have been situated a little below the entrance of Cecropia, free admission to which could scarcely have been permitted to strangers in those barbarous ages. But when the principal sacred edifices were erected on the south side of the Acropolis, and the city began to spread over the valleys to the south and west of the citadel, the Agora may have extended into the western side of the same space, with that most ancient place of popular assembly, the Pnyx, above the middle of it. By degrees the city stretched round the Acropolis, and the Agora became enlarged in the same direction; until at length the best inhabited part being on the north side of the fortress, and the old Agora having been defiled by the massacre of Sylla, and its buildings beginning to fall into decay, the new Agora became fixed, about the time of Augustus, in the situation where a portal of it is still to be seen. And although the city has contracted its circuit since that time, the southern and western parts of the ancient site having become quite uninhabited, yet the position of the central and most frequented quarter is the same as in the time of the Romans, and the modern Bazaar occupies exactly the same situation as the Eretrian or Roman Agora.¹ The removal of the Agora to that part of the town which formerly belonged to the demus of Eretria, Mr Hawkins rightly conceives to have taken place subsequently to the siege of Athens by Sylla, and the cruel butchery which followed the capture of the place. "After the Ceramicus had been polluted with the blood of so many citizens," says he, "the Agora was removed to a part of the city which was at this period in every respect more central and convenient for it, and where it is remarkable that the market of the modern Athenians still continues to be held at the present day."²

Its sections or divisions. Our detailed description of the Agora must necessarily be brief. It contained a street lined with Mercuries, and forming the communication between the Stoa Basileus and the Poecile. The Macra Stoa was a range of porticoes extending from the Peiraic gate to the Poecile, behind which rose the hill called Colonus Agoræus, where Meton erected a table for astronomical purposes. The Leocorium stood also in the Ceramicus, which, as classical readers know, is often used synonymously with Agora. Pausanias makes no mention of this monument, which was erected in honour of the daughters of Leos, who had devoted themselves for their country, and near which the tyrant Hipparchus was slain by Harmodius and Aristogeiton. The Ceramicus also contained the Agrippæum or theatre of Agrippa, the Palæstra of Taureas, and the Stoa of the Thracians and of Attalus. The portion strictly appropriated as a market-place was divided into sections, distinguished from one another by appellatives descriptive of the various articles exhibited for sale. Thus we read of the γυναικεία αγορά, where women's apparel was usually sold; of the ἰχθυοπωλῆς αγορά, or fish-market; of the ἡματιοπωλῆς αγορά, or clothes-market; and of the αγορά Ἀργείων, Θεῶν, Κεραύων, where, among other things, stolen goods were, it seems, publicly disposed of. The quarter denominated Cyclus from its form, was the slave and provision market. A peculiar stand was allotted to each vender, who, when he had once chosen his station, was not allowed afterwards to change it.³ The common-hall of the Athenian mechanics was situated in the Ceramicus,

which seems to have been the great resort of the lower orders, including courtesans, who, according to Lucian and the scholiast on Aristophanes, principally frequented this part of the city. In the new Agora were an altar erected to Pity, and two gymnasia; one founded by Ptolemy the son of Juba the Libyan, the other supposed to have been established by Ptolemy Philadelphus, and each denominated Ptolemeium. To the northward of Panaromeni there was found among the ruins,⁴ many years ago, an inscribed pedestal, which had supported a statue of Ptolemy the son of Juba; and Juba is said by Pausanias to have been honoured with a statue in the Gymnasium of Ptolemy.⁵ So much for the Ceramic edifices.

Theseium. The next structure which demands our attention is the Theseium or temple of Theseus, which stood, and happily still stands, at no great distance from the site of the monuments last mentioned. The circumstances which led to the erection of this noble edifice are deserving of commemoration. About eight centuries after the death of Theseus, the Athenians suddenly became ashamed of the ingratitude of their ancestors towards their great benefactor, in driving him out of Athens to die by violence in a foreign country. This tardy fit of remorse is said to have been occasioned by a rumour, which readily gained belief, that the spectre of the patriot hero had been seen fighting against the Persian host at Marathon. The Pythia was consulted in reference to the supposed apparition, which of course was duly authenticated; and generously directed the Athenians to remove his remains to the city, which even his spirit had defended, and to honour him as a demigod. His bones, with a brazen helmet and a sword lying beside them, were discovered in the island of Scyrus, by Cimon, son of Miltiades. They were received at Athens with processions and sacrifices. Games and festivals were instituted in his honour; a heroum was erected to him on the Colonus Hippius, and a temple, the Theseium, in the city. This building was equalled in sanctity only by the Parthenon and Eleusinium; its sacred inclosure was so large as occasionally to serve as a place of military assembly; and it enjoyed the privileges of a sanctuary, which rendered it a prison. It was built about 465 years before the Christian era, and about thirty years anterior to the erection of the Parthenon.⁶ The Theseium is a peripteral hexastyle, with thirteen columns on the sides, and it faces the east. The cell within measures 40 feet in length and 20 feet in breadth. It has a pronaos and a posticum, each of which is formed by a prolongation of the side walls of the cell, having two columns between the antæ; but the depth of the pronaos is greater than that of the posticum, and the depth of the portico of the pronaos is greater than that of the portico at the back of the temple. The side porticoes are only six feet in breadth; but the thirty-four columns of the peristyle are nearly three feet four inches in diameter at the base, and about nineteen feet in height, with an intercolumniation of five feet four inches, except at the angles, where the interval is smaller. The stylobate is formed of only two steps; and the height of the temple, from the bottom of the stylobate to the summit of the pediment, is 33.5 feet. The eastern or chief front only of the temple was adorned with sculptures; and, accordingly, the ten metopes of that front, with the four adjoining metopes of either flank, are those in which the labours of Hercules

¹ *Topography of Athens*, pp. 103, 104, 105.

² Pausanias, *Attic.* 2 and 16; Herodot. vi. 108; Thucyd. vi. 54, i. 20; Julius Pollux, vii. 18; Plato *de Leg.* xi.; Cicero *de Fin.* v. 1.

³ Stuart's *Antiquities of Athens*, vol. iii. c. 1.

⁴ Leake's *Topography of Athens*, p. 119.

⁵ Plutarch in *Thes. et Cimon.*; Diodor. Sicul. l. iv. c. 62; Pausan. *Attic.* 17, 30; Plutarch *de Exil.*; Thucydides, l. vi. c. 61; Diodor. Sic. ubi supra; Plut. *Paral. in Thes.*; Hesych. vv. Θησεῖον et Θησεῖον-ψ; *Topography of Athens* (additional note), p. 392.

Athens.

and Theseus are represented in alto-relievo, while the other metopes are plain.¹ The roof of the cell of the Theseium is modern; the greater part of the beams and lacunaria of the porticoes are wanting; and the sculptures have been purposely defaced by the Turks. When the temple was converted into a Christian church, the two columns of the pronaos were removed to make room for the altar; and a door was at the same time pierced in the western wall. But when Athens was taken by the Turks, who were in the habit of riding into the churches on horseback, this door was shut up, and a smaller one made in the southern wall. In other respects, however, the temple is complete. It is formed entirely of Pentelic marble, and stands upon an artificial foundation constructed of large quadrangular blocks of ordinary limestone. At the north-western angle of the temple, where the hill upon which it stands is precipitous, six courses of the foundation now appear above ground, and are gradually receiving so much injury from the effect of the periodical rains as to threaten the safety of this part of the building. The sculptures of the Theseium are upon the eighteen metopes already mentioned, upon a frieze over the entrance of the pronaos, and upon another over that of the posticum. All the metopes in the front of the temple which can be deciphered relate to the labours of Hercules, the kinsman, friend, and companion of Theseus; whilst those on the two flanks relate exclusively to the achievements of the hero to whom the edifice was more immediately dedicated. The subject of the frieze over the columns and antæ of the posticum or back vestibule was the most celebrated event in the life of Theseus, his contest with the Centaurs; and, from the analogy of the front and flank metopes, it may reasonably be presumed that the pannel over the pronaos, which has been completely defaced, related to the exploits of Hercules. The interior of the Theseium, as we learn from Pausanias, was anciently decorated with paintings, representing the achievements of Theseus, particularly his battle with the Amazons, and the fight of the Centaurs and Lapithæ, where his prowess was most remarkably signalized.² The stucco upon which they were painted is still apparent, and shows that each painting covered the entire wall from the roof to within two feet nine inches of the pavement.

Agrauium, &c.

Some difficulty exists as to the relative sites of the Anaceium and Agrauium, which Pausanias next proceeds to describe. We know, however, that the Anaceium stood below the Agrauium; and from comparing the statements of Herodotus, Pausanias, and Euripides in reference to the latter, Colonel Leake has made it pretty evident that the position of this ancient sanctuary of the Athenians was near the foot of the Acropolis, in some part of the precipices which are situated to the eastward of the Grotto of Apollo and Pan. These precipices were called

the long rocks (*μακραι πετραι*); and here it appears to have been that the Persians under Xerxes ascended the steepest part of the hill, near the temple of Agrauius, in order to scale the ramparts of the citadel; an enterprise in which they were completely successful. The Agrauium was rather a sanctuary or sacred inclosure (*ιερον τεμενος*) than a temple, and some traces of its existence are still discoverable near the centre of the north side of the Acropolis. The Anaceium,³ or temple of the Dioscuri, a building of great antiquity, stood immediately below the Agrauium, close to the rock of the Acropolis, and near the gate which now leads into an exterior inclosure of the citadel, forming the modern approach from the town to the Propylæa. It is said to have contained several paintings by Polygnotus and Micon. Near to the Agrauium was the Prytaneium, where the written laws of Solon were deposited. It stood above the level of the main body of the city, and formed the commencement of a street called Tripodes, leading to the sacred inclosure of Bacchus, near the theatre; a circumstance which seems to fix its site at the north-eastern angle of the Acropolis, one of the very finest situations in Athens, commanding a view of the sea, as well as of all the northern part of the city and its plain. Not far from the supposed site of the Prytaneium is a church of Panagia Vlastiki, where are still seen the remains of some important building, probably the temple of Serapis, which is the first edifice mentioned by Pausanias upon descending from the Prytaneium into the lower parts of the city. "The ruins at the church of Vlastiki," says Colonel Leake, "are in a line between the new Agora and the arch of Hadrian: the building therefore to which they belonged probably stood in the street leading from the Agora to the Olympeium and Hadrianopolis, of which the arch of Hadrian formed the termination."⁴ The buildings erected by Hadrian in this part of the city were denominated Hadrianopolis, as we learn from an inscription on the remains of the triumphal arch just mentioned.⁵

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The Olympeium, Olympieium, or Olympium, one of the Olympeium. most ancient temples in Athens, was supposed to have been originally founded by Deucalion. But it seems to have fallen into decay at a very early period; for, about the year 530 before the Christian era, Peisistratus commenced a new and more magnificent structure upon the site of the old building. The ancient Athens, however, was not the only place in the world where it was found easier to begin than to finish a temple. The expensive wars in which the Athenians were not long afterwards engaged put a stop to the progress of the building; and nearly four centuries elapsed, including the most flourishing periods of the republic, before any attempt was made to complete it. At length, however, Antiochus Epiphanes, king of Syria, about the year 174 B. C. undertook this task, and a magnificent edifice of the Corinthian order was be-

¹ Leake's *Topography of Athens*, p. 38 and 392.

² For an account of the subjects of the sculptures in high relief which adorn the metopes of the front and two flanks of the temple, and the friezes over the posticum and pronaos, see Stuart's *Antiquities of Athens*, vol. iii. and especially Colonel Leake's additional note on the Theseium in his *Topography of Athens*, p. 392, to which we have been almost exclusively indebted for the above particulars.

³ This building was named *Ανακείον* because the Dioscuri (Castor and Pollux) were commonly called *οι ανακτες* by the Athenians. Plutarch, *Vit. Thes.*; Ælian, *Hist. iv.* 5; Harpocr.

⁴ *Topography of Athens*, p. 134.

⁵ Above the north-west side of the arch there is inscribed ΑΙΔΕΙΣΑΘΗΝΑΙΘΗΣΕΩΣΗΠΙΝΙΠΙΟΛΙΣ, that is, *αἰδεῖς ἡσὶς Ἀθῆναι Θησεως ἡ πόλις*, *This is Athens, formerly the city of Theseus*; and, on the opposite side, are the following characters: ΑΙΔΕΙΣΑΔΡΙΑΝΟΤΚΑΙΟΤΧΙΘΗΣΕΩΣΠΟΛΙΣ, *αἰδεῖς ἡσὶς Ἀδριανου και ουχι Θησεως πόλις*, *This is Hadrianopolis, not the city of Theseus*. Dr Chandler has supposed that the first words of the former inscription should be read *αἰδεῖς Ἀθῆναι*, instead of *αἰδεῖς ἡσὶς Ἀθῆναι*, or rather *αἰδ' ἡσ' Ἀθῆναι*; but Spon and Wheler, Stuart, and a multitude of others, including Kavasila (Cabasilas), a modern Greek, have all declared in favour of the former interpretation; and where the same contracted form of expression occurs in other inscriptions, Gruter, Crusius, and Meursius invariably resolve it as we have done. In both cases, however, the meaning is the same. That side of the arch which fronted the ancient city pointed it out, whilst the portion of the monument which looked towards the erections of Hadrian in like manner marked them out to the readers of the legend.

Athens. gun by Cossutius, a Roman architect. But upon the death of Antiochus in 164 B. C. the work was again interrupted; and on the capture of Athens by Sylla, seventy-eight years afterwards, the columns prepared for the building were carried away by order of the conqueror, and erected as part of the temple of Jupiter Capitolinus at Rome. The Olympieum was in this imperfect and mutilated condition when the kings and states in alliance with or in subjection to Augustus undertook the completion of the edifice at their joint expense. But, from various causes, the work was once more interrupted; and the honour of completing and dedicating the temple, as well as of erecting the statue of the divinity, formed (if we may believe Pausanias) of ivory and gold, was reserved for Hadrian, six centuries and a half after its foundation by Peisistratus.¹ There can be little doubt that the cluster of magnificent columns of Pentelic marble at the south-east extremity of the city Athens, near the Ilissus, belonged to the celebrated temple of the Olympian Jupiter. They are of the Corinthian order, sixteen in number,² six feet and a half in diameter, and above sixty feet in height, standing upon an artificial platform, supported by a wall, the remains of which show that the entire peribolus or circuit must have been about 2300 feet, or little short of half a mile. From the existing remains, it appears that the temple consisted of a cell, surrounded by a peristyle, which had ten columns in front and twenty on the sides; that the peristyle, being double on the sides and quadruple at the posticum and pronaos, consisted altogether of 120 columns; and that the whole length of the building was 354 feet, and its breadth 71. "Such vast dimensions," says Colonel Leake, "would alone be sufficient to prove these columns to have belonged to that temple, which was the largest ever built in honour of the supreme pagan deity, and one of the four most magnificent ever erected by the ancients, even if Thucydides had not pointed out this side of the city as the position of the Olympieum, or if Vitruvius had not left us a description of this edifice exactly conformable with the existing ruins."³

Temples of Juno and Jupiter Panhellenius, &c.

To the taste and munificence of Hadrian Athens was also indebted for a temple of Juno, another dedicated to Jupiter Panhellenius, and a temple common to all the gods, or Pantheon. But the most remarkable edifice next to the Olympieum, erected by this emperor, was that which has been denominated the Stoa of Hadrian. When complete, it was a quadrangle of 376 feet by 252, adorned at the western end with a portal and colonnade of Corinthian columns, 120 in number, and each three feet in diameter; but of these, which were formed of Phrygian marble, only ten are at present standing. In the centre are the ruins of a building which now forms part of the church of Megali Panagia, and consist, on one side of the remains of an arch, and on the other of an architrave, supported by a pilaster, and three Doric columns, each one foot nine

inches in diameter, and of a declining period of the arts: round the inside of the inclosure, at a distance of twenty-three feet from the wall, are also vestiges of a colonnade; and in the northern wall, which still exists, there is one large quadrangular niche thirty-four feet in length, and two circular niches equal to it in diameter. The general form and distribution of this building, which Pausanias notices as the most magnificent of Hadrian's works, are those of a stoa, or place of resort for walking, conversation, and reading; and the apartments projecting from the wall of the peribolus accord precisely with the *οικηματα* mentioned by Pausanias, which were resplendent with alabaster and gilding, and adorned with pictures and statues. The building at the church of the great Panagia in the centre answers, Colonel Leake thinks, to the library with which we know from several ancient authors⁴ besides Pausanias, that this magnificent stoa was provided.⁵

Athens.

Besides the street leading from the Prytaneium to the Olympieum, there was another which branched off from the same place towards the Lenæum or sacred inclosure of Bacchus, adjacent to the theatre, which was called the Tripodes, from the tripods there dedicated by the leaders of the chori victorious in the scenic contests decided in the Dionysiac theatre. Several of these tripods were placed upon temples dedicated to Bacchus and other deities, and erected either in the quarter of the Tripodes or within the inclosure of the Lenæum; others, again, stood upon columns and rocks near the theatre, as the remains of the monuments still indicate. Of the former description was the beautiful little choragic monument of Lysicrates, vulgarly called the Lantern of Demosthenes, the apex of which proves beyond a doubt that it once supported a tripod, while its closed construction shows that the victorious choragus who built this gem of art (*νεως υποκειμενος τω τριποδι*) preferred bestowing all the expense on external decorations.⁶ From the inscription on this monument it appears to have been erected in the archonship of Evænetus, about the year 335 B. C.;⁷ and it is consequently the oldest known specimen of the Corinthian order, although considerably posterior to the epoch of its invention.⁸ Colonel Leake thinks that the street of Tripodes passed at the foot of the rocks under the east end of the Acropolis; and that, after reaching the south-eastern angle of the rocks, it had one branch leading into the Lenæum, and another into the theatre of Bacchus. The Lenæum, situated on the western side of the theatre, was a most ancient sanctuary of Bacchus; having within its peribolus or inclosure two other temples similarly dedicated, with a couple of statues, one of which was surnamed Eleuthereus,—and containing several pictures representing different events in which the rosy god was believed to have participated. This is the temple to which Thucydides alludes as that of Bacchus in Limnis, or Bacchus in the

Tripodes, Lenæum, Dionysiac Theatre, &c.

¹ Thucyd. l. ii. c. 15; Pausan. *Attic.* 28; Plutarch in *Solon*; Vitruv. *Proem.* in l. vii.; Liv. *Hist.* l. xli. c. 20; Sueton. in *August.* 60; Spartian. in *Vit. Hadrian.*

² There was a seventeenth column belonging to the western front standing until the year 1760, when it was taken down by order of the governor of Athens, to build a new mosque in the Bazaar. (Stuart's *Antiq. of Athens*, vol. iii. p. 15; Chandler's *Travels in Greece*, c. 15.)

³ *Topography of Athens*, 43. See also note, p. 401. The other three temples alluded to in this extract were that of Diana at Ephesus, that of Apollo near Miletus, and the Doric temple sacred to Ceres and Proserpine at Eleusis. The first was 425 feet long by 220 broad, the second 368 by 165 feet, and the third 216 by 178 feet.

⁴ Eusebius, *Chron. Can.*; Cassiodorus, *Chron. in Hadrian.*; Syncellus, *Chron.* p. 349.

⁵ *Topography of Athens*, 120. Spon and Wheeler conceived this building to be the temple of Jupiter Olympius, in which they were certainly mistaken; and Stuart thought it the Poecile, which is incompatible with the fact he himself admits, that the columns were the work of Roman times.

⁶ Stuart's *Antiq. of Athens*, vol. i. c. 4; Leake's *Topography*, 155.

⁷ The inscription, which is upon the architrave, testifies that Lysicrates, son of Lysitheides, led the chorus when the boys of Acamantis gained the victory, when Theon played the flute, when Lysiadès wrote the piece, and when Evænetus was archon.

⁸ This order was first employed in the construction of the temple of Minerva Alea at Tegea about the year 385 B. C., or half a century prior to the period in question. (Pausan. *Arcad.* c. 45.)

Athens.

marshes.¹ The Dionysiac Theatre was situated near the south-eastern angle of the citadel, where vestiges of it are still to be seen. Like most of the other theatres of Greece, its extremities were supported by piers of solid masonry, while the middle of it was excavated in the side of the hill. From the existing ruins, however, it is difficult to form any correct estimate of the dimensions of this theatre; but if we are to credit Plato's statement, that it was capable of containing more than 30,000 spectators,² it must have descended much lower down into the plain than has been generally imagined, or than the actual remains would lead us to suppose. The Hierum of Epidaurus, which could not have contained more than 15,000 spectators, allowing only eighteen inches for each person, was 366 feet in diameter; and the theatres at Argos and Sparta, as well as that near Dramatzus in Epirus, were about 500 feet in diameter, yet could not have admitted more than 30,000 spectators, allowing for each the width of seat or room just mentioned. If Plato's statement be correct, it seems therefore to follow, that the diameter of the Dionysiac theatre must have been not less than from 450 to 500 feet, and consequently that it must have extended quite close to the foot of the hill, where, indeed, the level space necessary for the orchestra and the scene could alone have been found.³ This celebrated theatre contained statues of all the great tragic and comic poets, the most conspicuous of which were naturally those of Æschylus, Euripides, and Sophocles, among the former, and that of Menander among the latter; and Dicæarchus informs us that it was accounted the most beautiful structure of the kind in existence. A little to the eastward stood the Odeium of Pericles, with a roof formed out of the masts and yards of the Persian ships captured at Salamis, and rising to a point like the pavilion of Xerxes, which the whole structure indeed was intended to represent. It was richly decorated with columns, and during the dominion of the Tyrants was generally occupied by their satellites. During the siege of Athens by Sylla, Aristion, general of Mithridates, who was intrusted with the defence of the city, set fire to this monument of Athenian glory, lest the enemy should make use of the timber for the purpose of assaulting the Acropolis; and although Vitruvius informs us that it was afterwards restored at the expense of Ariobarzanes, king of Cappadocia, not a vestige or trace of the edifice remains. In the immediate vicinity of the citadel were a temple of Æsculapius, with a fountain; the temples of Themis, Venus Pandemus, and Persuasion; the monument of Hippolytus; besides the temple of Ceres Chloe, some remains of which are supposed to exist at the foot of the Acropolis, near the ascent which formerly led to the citadel.⁴

Acropolis.

The ancient city of Cecrops is now a fortress or citadel, with a thick irregular wall inclosing a large area about twice as long as it is broad, and standing on the outer ledges of an elevated rock abruptly terminating in precipices on every side, except the front, which is towards the Peiræus or west, and by which alone it is accessible. Some portions of the ancient wall may still be seen on the outside, particularly at the two extreme angles; and in many places it is patched with fragments of columns and

marbles taken from the ruins. The physical character of this remarkable rock continues nearly the same as in the days of Cecrops; and notwithstanding all the devastations which war, time, and fanatical barbarism have committed, it still contains a large portion of the remaining antiquities of Athens, and consequently demands a corresponding share of the researches both of the artist and topographer. Anciently the Acropolis was filled with monuments of Athenian glory, and exhibited an amazing concentration of all that was most perfect in art and most magnificent in architectural decoration. It appeared, so to speak, as one entire offering to the divinity, surpassing in excellence, and unrivalled in richness and splendour. It was the peerless gem of Greece, the glory and the pride of art, the wonder and envy of the world. Heliodorus, surnamed Periegetes or the Guide, employed no less than fifteen books in describing it; the curiosities of various kinds, with the pictures, statues, and pieces of sculpture, supplied Polemo Periegetes with matter for four volumes; and Strabo seems to think that as many more would have been required for a minute description. The number of statues, in particular, was prodigious. Tiberius Nero, who had a remarkable taste for appropriating works of art which the genius and means of others had executed, plundered the Acropolis, as well as Delphi and Olympia; yet notwithstanding this spoliation, Athens, in the time of Pliny, had no fewer than three thousand remaining, of which the most valuable portion were in the Cecropian citadel. Even Pausanias seems to be distressed by the multiplicity of objects which here engaged his attention, and uncertain where to commence his description. Such was the Acropolis. What it is, Stuart and Revett, and Cockerell and Leake, and other writers of inferior note, have told us; and to their learned and accurate researches we are indebted for the correct knowledge, which we have at length attained, of those magnificent buildings which adorned the citadel of Athens. We do not say that many curious discoveries connected with the monuments of the Acropolis may not still be made, when its platform shall have been cleared of the wretched buildings which now cover its surface and disfigure its appearance; but in regard to the three great edifices, namely, the Propylæa, the Parthenon, and the Erechtheium, it is probable, from what has been already discovered, that but little remains to be done.

The western side of the Acropolis, which, as we have already said, furnished, and still furnishes, the only access to the summit of the hill, was about 168 feet in breadth; an opening so narrow that, to the artists of Pericles, it appeared practicable to fill up the space with a single building, which, in serving the main purpose of a gateway, should contribute to adorn as well as to fortify the citadel. This work, the greatest production of civil architecture in Athens,⁵ which rivalled the Parthenon in felicity of execution, and surpassed it in boldness and originality of design, was begun in the archonship of Euthymenes, in the year 437 B. C., and completed in five years, under the directions of the architect Menesicles, at the enormous cost, if we may believe Heliodorus, of two thousand and twelve talents.⁶ Of the space which formed the natural entrance

¹ Thucydides, ii. 15.² Plato in *Conviv.* iii. 173, 175, ed. Serran.³ Philostratus, in his *Life of Apollonius Tyanæus*, says, Περικλῆς μὲν Προπυλαία πρὸς φιλοτιμίαν ἤρκει καὶ Παρθενῶν, l. ii. c. 5; and Demosthenes, in his oration against Androtion, gives a similar indication of the Propylæa having been considered upon a level with the Parthenon in point of architectural skill and decoration: οἱ τὰ Προπυλαία καὶ τὸν Παρθενῶνα οἰκοδομήσαντες ἐκίνοι καὶ τὰλλα πάντα ἀπὸ τῶν βαρβάρων ἱερά κομίσαντες, κ. τ. λ. p. 597, ed. Reiske.⁴ This is incredible for many reasons. In particular, it appears, from Thucydides, that the expense of all the works of Pericles, including the Odeium, the mystic temple at Eleusis, the Parthenon, and one of the long walls, as well as the Propylæa, did not amount to three thousand talents; and it is therefore inconceivable that the last-mentioned edifice, one of five of which the Parthenon was the chief, should have cost two thirds of this sum. See a very learned note on this subject by Colonel Leake. (*Topography of Athens*, p. 406.)⁵ *Topography of Athens*, 60.⁶ *Ibid.* 162.

Athens. to the Acropolis, 58 feet near the centre were left for the great artificial entrance, and the remainder on either side was closed by wings projecting 32 feet in front of the grand central colonnade. The entire building received the name of Propylæa from its forming the vestibule to the five gates or doors, still in existence, by which the citadel was entered.¹ The wall in which these doors were pierced was thrown back about 50 feet from the front of the artificial opening of the hill; and the whole may, therefore, be said to have resembled a modern fortification, the Propylæum properly so called representing the curtain, and each of the two wings presenting a face and flank or gorge like two adjoining bastions. This incomparable edifice was constructed entirely of Pentelic marble. The Propylæum or great vestibule in the centre consisted of a front of six fluted Doric columns, mounted upon four steps which supported a pediment, and measuring five feet in diameter and near 29 in height, with an intercolumniation of seven feet, except between the two central columns, which were 13 feet apart in order to furnish space for a carriage-way. Behind the Doric colonnade was a vestibule 43 feet in depth, the roof of which was sustained by six Ionic columns in a double row, so as to divide the vestibule into three aisles or compartments; and these columns, although only three feet and a half in diameter at the base, were, including the capitals, nearly 34 feet in height, their architraves being on the same level with the frieze of the Doric colonnade. The ceiling was laid upon marble beams, resting upon the lateral walls and the architraves of the two rows of Ionic columns; those covering the side aisles being 22 feet in length, and those covering the central aisle 17 feet, with a proportional breadth and thickness. Enormous masses like these, raised to the roof of a building, standing upon a steep hill, and covered with a ceiling which all the resources of art had been exhausted to beautify, might well excite the admiration of even a plain matter-of-fact topographer like Pausanias, and at once account for and justify the enthusiasm with which he expresses himself when speaking of the roof of the Propylæa.² Of the five doors at the extremity of the vestibule, the width of the central and largest was equal to the space between the two central columns of the Doric portico in front, which was the same as that between the two rows of Ionic columns in the vestibule; but the doors on either side of the principal one were of diminished height and breadth, and the two beyond these again were still smaller in both dimensions. These five gates or doors led from the vestibule into a back portico eighteen feet in depth, which was fronted with a Doric colonnade and pediment of the same dimensions as those of the western or outer portico, but placed upon a higher level, there being five steps of ascent from the level of the latter to that of the former. From the eastern or inner portico there was a descent of one step into the adjacent part of the platform of the Acropolis.

Wings. The wings of the Propylæa were nearly symmetrical in front, each presenting on this side a wall adorned only with a frieze of triglyphs, and with antæ at the extremities. The extreme simplicity of the wings in this direction was characteristic of the work of defence, of which

they formed so important a part; while the flanks of the bastions (if we may be allowed the expression) were also uniform in their construction, each presenting a Doric front of three columns in antis, each three feet in diameter, supporting pediments, the summits of which were on a level with the frieze of the Propylæum properly so called. Besides, the inner or southernmost column of each wing stood in a line with the great Doric columns of the Propylæum; and as both these columns and those of the wings were upon the same level, the three porticoes were all connected together, and the four steps which ascended to the Propylæum were continued also along the porticoes of the two wings. But here the symmetry of the building ended; for, in regard to interior size and distribution of parts, the wings were exceedingly dissimilar. In the northern or left wing, a porch of twelve feet in depth conducted by three doors into a chamber of 34 feet by 26, the porch and chamber thus occupying the entire space behind the western wall of that wing;³ whereas the southern or right wing consisted only of a porch or gallery of 26 feet by 16, which, on the south and east sides, was formed by a wall connected with and of the same thickness as the lateral wall of the Propylæum, and, on the west side, had its roof supported by a narrow pilaster, standing between the north-west column of the wing and an anta, which terminated its southern wall. In front of the southern or right wing there stood, so late as the year 1676, a small Ionic temple, dedicated to Victory Apteros (without wings). Wheeler informs us that it was built of white marble, and about fifteen feet in length by eight or nine in breadth; and we learn from Spon that it was then used by the Turks as a powder-magazine. These brief particulars are the only memorials we now possess of this interesting monument; with the exception of a few fragments still to be seen on the spot, and four marbles, with figures in relief, forming part of the frieze, which are now in the British Museum, having been brought away by Lord Elgin about the year 1804. It may either have been destroyed in the siege of 1687, when the Venetians particularly directed their batteries against the entrance of the citadel; or it may have been accidentally blown up by the explosion of a bomb-shell; or, finally, the Turks may have removed it in order to make room for the modern work which occupies its place, and appears to have been added about the time of the siege.⁴ The left wing of the Propylæa was decorated with paintings by Polygnotus, representing a series of events connected with the siege of Troy; and the structure was ornamented throughout with numerous equestrian statues. We may add, that the Propylæa have ceased to be the entrance of the Acropolis. The passage between the columns of the centre has been walled up almost to their capitals, and above is a battery of cannon. The way now winds before the front of the ancient structure; and turning to the left among rubbish and wretched walls huddled together in the most irregular manner, the stranger proceeds to the back part of the vestibule and the five door-ways, without almost suspecting that he is in the midst of that celebrated structure which formed the external glory and defence of the rock of Cecrops.⁵

Athens.

¹ Helioid. apud Harpocrat. v. Προπυλαία.

² Τα δὲ Προπυλαία λίθου λινοῦ τὴν οὐρανὴν ἔχει, καὶ κοσμοῦ καὶ μεγάλου τῶν λίθων μέχρι γέφυρας προεχέει. (Attic. c. 22.)

³ "In stating that the temple of Victory was on the right side of the Propylæa," says Colonel Leake, "and the οἰκημα εἶχον γραφάς, or chamber containing pictures of Polygnotus and other artists on the left, few persons will doubt that Pausanias meant the right and left hand of the traveller, in his progress from the lower part of the city towards the Acropolis; for although passages may be found in this author where his meaning in the use of the words *right* and *left* is ambiguous, it can never be so where it is his evident intention to describe a succession of objects on any particular line, as undoubtedly occurs in his account of the Propylæa and the adjacent monuments." (Topography of Athens, 195, 196.)

⁴ Fanelli, Atene Attiche, p. 308.

⁵ Topography of Athens, p. 176, et seq. In the above description of the Propylæa, we have principally followed Colonel Leake, whose known accuracy renders him a safe guide in all matters connected with the topography of this celebrated city.

Athens.
Parthenon.

The Parthenon, or temple of the Virgin Goddess, was placed upon the highest platform of the Acropolis, which was so far elevated above its western entrance that the pavement of the peristyle of this renowned edifice was upon the same level as the capitals of the columns of the eastern portico of the Propylæa. It occupied the site of an older temple called Hecatompædon (from its being a hundred feet square), which had also been dedicated to Minerva, but had been destroyed by the Persians under Xerxes during the sack of Athens; and it was constructed entirely of white marble from the quarries of Mount Pentelicon. It consisted of a cell, surrounded with a peristyle, having eight Doric columns in the two fronts, and seventeen in the sides, or forty-six in all; each column six feet two inches in diameter at the base, and thirty-four feet in height, standing upon a pavement or platform, to which there was an ascent of three steps. The total height of the temple above its platform was about 68 feet, its length 228, and its breadth 102 feet. Within the peristyle, at both ends, there was an interior range of six columns, five feet and a half in diameter, standing before the end of the cell, and forming a vestibule to its door, two steps above the pavement of the peristyle. The cell, which was 625 feet in breadth within, was divided into two unequal chambers, of which the western was about 44 feet in length, and the eastern nearly 99 feet. The ceiling of the former was supported by four columns of about four feet in diameter, and that of the latter by sixteen columns of about three feet. It is not known of what order were the intercolumns of either chamber; but those of the western one having been 36 feet in height, it is probable that their proportion was nearly the same as that of the Ionic columns in the vestibule of the Propylæa, and that the same order was used in the interior of both these contemporary edifices. In the eastern chamber of the Parthenon, the smallness of the diameter of the columns leaves little doubt that there was an upper range, as in the temples of Pæstum and Ægina. But it is to be lamented that no remains of any of them have been found, as these might have presented new proofs of the taste and invention of the architects of the age of Pericles. Such, then, was the simple construction of this magnificent temple, which, by its united excellencies of materials,¹ design, and decoration, internal as well as external, has been universally considered the most perfect which human genius and skill ever planned and executed. Its dimensions were sufficiently large to produce an impression of grandeur and sublimity, which was not disturbed by any obtrusive subdivision of parts; and, whether viewed at a small or a great distance, there was nothing to divert the mind of the spectator from contemplating the unity as well as majesty of mass and outline; circumstances which form the first and most remarkable characteristic of every Greek temple erected during the purer ages of Grecian taste and genius. Nor was it until the eye had become satiated with the contemplation of the entire edifice that the spectator could be tempted to examine the decorations with which this building was so profusely adorned; for the statues of the pediments, the only decoration which was very conspicuous from its magnitude and position, being inclosed within frames, which formed an essential part of the design of either front, had no more obtrusive effect than an ornamented capital to a single column.²

Athens.
Decorations.

It is not our intention, in this place, to attempt any detailed or minute description of an edifice which would require a volume for its complete illustration. We may observe, generally, that as it was one of the great objects of Pericles to furnish employment in every branch of art to the ingenious and skilful artists with whom Athens at that period abounded, so he had contrived that the temple should be of a design the best adapted to the decorations of sculpture, and that it should be adorned with every species of it which was most esteemed among the Greeks. Within the cell was a specimen of chryselephantine sculpture, having but one rival in Greece, and that by the same master; under the colonnade, and in other parts of the temple, stood numerous statues in bronze; in the *reti* or pediments were two compositions near eighty feet in length, each consisting of about twenty entire statues of colossal size; under the exterior cornice, in harmony with the projecting features of that part of the building, were ninety-two groups, raised in high relief, from tablets about four feet three inches square; and, lastly, along the outside of the cell and vestibules ran a frieze of about three feet four inches in breadth and 520 in length, to which a relief, slightly raised above the surface of the naked wall which it crowned, was peculiarly applicable. This frieze represented the procession to the Parthenon on the grand quinquennial festival of the Panathenæa. No part of the work is now attached to the temple, but a tolerably correct idea of it may be formed from the drawings of Carrey, taken before the explosion which ruined the building, added to the designs of Stuart, and the fragments of the original which have been disinterred from the ruins and are now deposited in the British Museum. The procession is represented as advancing in two parallel columns from west to east; one proceeding along the northern, and the other along the southern side of the temple, part facing inwards after turning the angle of the eastern front, and part meeting towards the centre of that front. Of the metopes on the frieze of the peristyle, ninety-two in all, viz. fourteen on either front and thirty-two on either flank of the temple, the greater part on the northern side and the two fronts have perished by wanton violence or by casual destruction; whilst of those which belonged to the southern side, where the progress of dilapidation had been less ruinous, fifteen are now in the British Museum and one in Paris. From these fragments, together with the drawings of Carrey and Stuart, it has been conjectured, with much probability, that the metopes of the northern side related to the war of the Amazons, whilst those on the opposite side of the temple related principally to the other great fabulous Athenian contest with the Centaurs. The two pediments of the temple were decorated with magnificent compositions of statuary, one representing the birth of Minerva, and the other the contest between that goddess and Neptune for the possession of Attica; the birth being delineated on the western and the contest on the eastern pediment. The statue of the virgin goddess stood in the eastern chamber of the cell, and consisted of ivory and gold. On the summit or apex of the helmet was placed a sphinx, with griffins on either side. The figure of the goddess was represented in an erect martial attitude, and clothed in a robe reaching to the feet. On the breast was a head of Medusa wrought in ivory, and a figure of Victory about four cubits in height. The goddess held a spear in her hand, and an ægis lay at her feet; while on her right, and near

¹ The beautiful white marble with which nature furnished the Athenians was undoubtedly one of the great concurring causes of their unrivalled pre-eminence in architecture and statuary. Admitting as fine a surface, and presenting as beautiful a colour, as ivory, with a still sharper edge, it was admirably calculated to encourage the successive efforts of artists studious to excel their predecessors in the effects produced. (*Topography of Athens*, 211, 212.)

² *Topography of Athens*, p. 209, et seq.; Stuart's *Antiq. of Athens*, vol. ii. p. 57.

Athens. the spear, was the figure of a serpent, believed to represent that of Erichthonius. According to Pliny, the entire height of the figure was twenty-six cubits; and the artist Phidias had ingeniously contrived that the gold with which the statue was encrusted might be removed at pleasure. The battle of the Centaurs and Lapithæ was carved on the sandals; the gigantomachia and the battle of the Amazons were represented on the ægis which lay at her feet; and on the pedestal was sculptured the birth of Pandora. Pausanias also notices statues of Iphicrates, Pericles, his father Xantippus, Anacreon, and a brazen Apollo by Phidias. A portion of the southern wall was adorned with the battle of the giants; and here also were represented the conflict of the Athenians and Amazons, the battle of Marathon, and, lastly, the defeat of the Gauls in Mysia, sculptured at the expense of Attalus. The statue of Jupiter Polieus stood between the Propylæa and Parthenon; and the brazen colossus of Minerva by Phidias, dedicated from the tenth of the spoils of Marathon, and commonly called Minerva Promachus, appears to have occupied some part of the space between the Erechtheum and Propylæa, near the Pelasgic or northern wall. The architect of the Parthenon was Ictinus, who appears to have designed as well as executed the building; while Phidias had the control of the whole sculptural decorations, and with his own unrivalled hand executed those prodigies of art with which this great temple was adorned.¹

Erechtheum, &c. The Erechtheum, or temple of Erechtheus, so called from having been founded by Erechtheus, otherwise named Erichthonius, stood on the northern side of the Acropolis, and was one of the most ancient structures of Athens, being alluded to by Homer in the second book of his Iliad. There is, however, some confusion respecting this edifice, which seems to have been of a double construction, or divided into two parts, from the circumstance of the entire building being often called the temple of Minerva Polias as well as the Erechtheum; a practice which, as Colonel Leake remarks, is not at all surprising, considering that the temple of Minerva Polias was the most important part of the building, and that the statue of the goddess here worshipped was the most sacred in Attica, not even excepting the Minerva of the Parthenon. The truth, however, seems to be, that the Erechtheum consisted of two divisions; the eastern or more important forming the temple of Minerva Polias, the peculiar protectress of the citadel; and the western, that of Pandrosus. The former had a hexastyle front; before the colonnade was an altar of Jupiter, and under it were altars of Neptune and Vulcan; on the wall of the portico were the pictures of the Butadæ; and within the cell were the Erechtheian salt-well, the wooden statue of Minerva, with the lamp and brazen palm-tree before it, the altar of oblivion, the sacred serpent, the wooden statue of Hermes, the chair of Dædalus, and the Persian spoils. The Pandrosium, or chapel sacred to Pandrosus, one of the daughters of Cecrops, consisted of two chambers, of which the western was narrow, and opened into the portico at either end. The northern portico consisted of six Ionic columns, four in the front, with one on either flank; and it stood not far from the edge of the precipice, at the foot of which was the temenos of Agraulus. The southern portico was smaller than the northern, and its roof was supported by six caryatides, standing upon a podium and disposed like the columns of the northern portico, four in

front and two on the flanks. In the western or narrow chamber of this chapel grew the tree of Minerva, and the crooked Pancypus, which was held in such high veneration by the Athenians, and which the Persians, during their invasion, had burned but not destroyed. As to the eastern or interior chamber, which was contiguous to the cell of Minerva Polias, Colonel Leake thinks with Stuart that it formed the Cecropium, and quotes an inscription which countenances that opinion. "That Cecrops," says he, "was buried in this edifice appears to have been the common belief; and upon an inscribed marble (brought to England by Dr Chandler, and presented by the Society of Dilettanti to the British Museum) wherein different parts of this building are specified, we find the Cecropium mentioned in a manner which leaves no doubt of its having been an integral part of the building." The number of statues in the Acropolis was prodigious; and there were likewise several hiera or sanctuaries, such as that of Jupiter Polieus, Diana Brauronia, and the genius of good men. The whole of the Acropolis was surrounded by walls, built on the natural rock of which the entire hill is composed. But the most ancient part of these defences was constructed by the Tyrrhenian Pelasgi, who, in the course of their multifarious migrations, settled in Attica, and were employed by the Athenians of that early period in the erection of those ramparts which are often mentioned in the history of Athens under the name of Pelasgicum. Before the Persian war, however, they had fallen into decay; for on that occasion it was found necessary to erect palisades and other temporary defences. At a subsequent period the hill was re-fortified by Cimon and Themistocles; and it is probable that the greater part of the existing wall, although disfigured by the reparations of various ages, consists of the original Hellenic work hastily raised by these celebrated men, before the alarm occasioned by the Persian invasion had entirely subsided. "A part of the southern wall," says Colonel Leake, "where the profile is not less than sixty feet in height, appears in particular to consist almost entirely of the ancient Cimonian work; and the centre of the northern side still bears the strongest evidence of the haste with which Thucydides describes the fortifications of Athens to have been restored after the Persian war, when the Athenians returned to the city upon the departure of the barbarians, and found nothing left but a small part of the walls, and some of the houses which had been occupied by the Persian grandees."²

In his descent from the Propylæa, in the direction of Grotto of the outer Ceramicus and Academy, Pausanias describes the Pan, Arei-Cave or Grotto of Pan and the Areiopagus, both of which opagus. lay nearly in his route, and were the only objects of importance which had not yet been noticed by him. The grotto sacred to Apollo and Pan he describes as a cavern converted into a temple, and as situated under the Propylæa, near to a spring of water. Now, under the wall of the northern wing of the Propylæa, near the road which forms the present access to the citadel from the centre of the town, are both the cavern and the spring; the former containing two excavated ledges for the altars and statues of the two deities, together with several niches for votive offerings; and the latter supplying water to an artificial fountain a little way down the hill, whence the streamlet is conveyed by means of an aqueduct to the principal mosque, near the Bazaar.³ The Areiopagus, or hill of Mars, so called,

¹ *Topography of Athens, ubi supra*; Pliny, l. xxxvi. c. 5; Pausan. *Attic.* 25.

² Stuart's *Antiq. of Athens*, vol. ii.; Leake's *Topography*, p. 257 and 264.

³ The position of the cave of Apollo and Pan is exactly represented on a coin of Athens, which has been published by Stuart (*Antiquities of Athens*, vol. ii. p. 37) and Barthelemy (*Récueil des Cartes, &c. relatifs au Voyage du Jeune Anacharsis*, No. 27). It presents a view of the north-western side of the Acropolis, with the Propylæa to the right, the Parthenon to the left, and the colossal statue of Minerva Promachus between them; whilst the grotto of Pan is represented a little to the left of the stairs which formed an ascent for foot passengers from the north side of the city to the Propylæa. (*Topography of Athens*, p. 62, 63.)

Athens.

it is said, in consequence of that god having been the first person tried there for the crime of murder, was beyond all doubt the rocky height which is separated from the western end of the Acropolis by a hollow forming a communication between the northern and southern divisions of the city. It appears, however, that the court of Areiopagus and the temple of the Semnæ occupied only the eastern or highest summit of the hill, which agrees with the authorities indicating that other buildings were situated on the more western parts of the ridge. This court consisted originally of an open space, in which were an altar dedicated to Minerva Areia, and two rude seats of stone for the plaintiff and defendant, or the accuser and accused, as the case might be. But we learn from Vitruvius that, at a later period, this space was inclosed, and roofed in with tiles, and the ancient Druidical mode of administering justice in the open air altogether abandoned. The Persians occupied a position on the Areiopagus at the time when they made their attack on the western end of the Acropolis. Near to the spot on which the court stood was the temple of the Furies, as well as the building in which the sacred ship of the great Panathenaic festival was deposited.¹

Pnyx, Museum, &c.

In ancient times the Pnyx was the most common place of public assembly, especially during elections; but latterly it was less frequented for that purpose than the Dionysiac theatre, which has been already described. It appears to have been situated over against the Areiopagus, in view of the Propylæa, and near the city walls; and it was constructed for the meetings of the people, not with the magnificence of a regular theatre, but with a simplicity characteristic of the earlier and severer age of Grecian liberty. The orators addressed the people, not from a rostrum splendidly decorated, but from a *βῆμα* or plain pulpit of stone, which at first looked to the sea, but in the time of the Thirty was turned towards the interior of the country. Some traces of this ancient structure still exist on a height or eminence, the situation and bearings of which, to the north of the Museum and the west of the Areiopagus, accord perfectly with the position of the Pnyx, as determined by the statements of the Greek writers.² The range of hills which rises to the south-west of the citadel seems at some distant period to have borne the name of Lycabettus. Plato informs us that it was opposite the Pnyx, and Antigonus Carystius relates a fabulous story which would lead us to imagine that anciently it approximated more closely to the Acropolis than is at present the case. The Museum was another elevation in the same vicinity, and, like the Pnyx, it was included within the peribolus or circumference of the ancient walls. It derived its name from the poet Musæus, who was interred there. At a later period a monument was erected on this eminence by Philopappus, a descendant of the kings of Commagene in Syria, who, having been consul under the reign of Trajan, retired to Athens (as we learn from the inscription) to spend the remainder of his days, "from toils and cares remote," in the bosom of that renowned city. Among the inferior courts of judicature mentioned by Pausanias, after describing the Areiopagus, were the Parabystum, where petty causes were tried; the Trigonum, so called from its shape; and the Batrachium and Phœnicium, which probably received their names

from some peculiarities of colour in the edifices where they were held. The Helicæa, a tribunal of greater importance, is often alluded to by Aristophanes and other Greek classical writers. It was situated near the Agora, and so named from its being held *sub dio*, in the open air. The Palladium was a court where persons accused of murder were commonly tried. Those, however, who confessed to the act of slaying, but set up a justification of the deed, as, for example, that it had been done in self-defence, were sent to be judged in the Delphinium, a tribunal which probably derived its name from being situated near the temple of Apollo Delphinus.³

This completes our survey of the principal buildings, monuments, and localities within the city, which we have described as fully as the limits to which the present article is confined would possibly admit; omitting nothing which we considered of material importance, either for conveying a just notion of the ancient splendour and magnificence of Athens, as contrasted with its actual state of decay and ruin, or for enabling the reader to understand and appreciate the innumerable allusions, references, and descriptions with which the Greek writers, whether poets, historians, philosophers, or dramatists, abound. It now only remains, therefore, to notice briefly the remarkable edifices and situations in the suburbs and environs.

The quarter called Cœle was appropriated as a burying-ground, and consequently must have been without the city, since Cicero assures us that no one was allowed to be interred within the walls. Cimon and Thucydides were both entombed in this hollow space or valley, which Hesychius classes among the Attic demi, and which, according to Colonel Leake, was situated to the south of the Acropolis, near the gate of Lumbardhari, which answers to the Portæ Melitenses. There are indeed, he adds, some remarkable sepulchral grottoes just within the site of the gate, and the place is moreover contiguous to the quarter of the Pnyx where Cimon dwelt.⁴ Melite, another demus, is supposed to have been principally within the walls, and we learn from Demosthenes that it was not far from the Leocorium. Populous and well frequented, it contained the house of Phocion, a temple of Diana Aristobula erected by Themistocles, and another of Hercules Alexicacus, with a celebrated statue by Geladas, the master of Phidias. Here also was the place of rehearsal for the tragic actors, the Eurysaceum, or sanctuary of Eurysaces the son of Ajax, and the temple of Menalippus. Colyttus, a third suburban demus, contiguous to Melite, was remarkable as the birth-place of Plato, the prince of philosophers, and of Timon, the most celebrated of misanthropists; and Æschines the orator was said to have resided there for the long period of five and forty years. It is sometimes written Collyttus.⁵

The far-famed Ilissus, from which Athens was principally supplied with water, and which Plato in a well-known passage of his *Phædrus* has described as a perennial stream, is now almost always dry, its waters being drawn off, either to irrigate the neighbouring gardens or to supply the artificial fountains of the modern city. It rises to the north-east of the town, and, after a course of a few miles, loses itself in the southern marshes. Not far from the supposed site of the Lyceum it is joined by another stream, or rather water-course, which is believed to be the

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¹ Jul. Poll. viii. 10; Æschyl. *Eumenid.* 680; Herod. viii. 52.

² Jul. Poll. viii. 10; Harpocr. v. *Προπυλαία*; Aristoph. *Pac.* 659, *ubi et Schol.*; Plutarch, *Themist.*; Plato in *Crit.*

³ Galen in *Harpocr. Epidem.* iii. 3; Demosth. in *Aristocrat.* p. 643; Cf. J. Poll. viii. 10.

⁴ *Topography of Athens*, 116; Dodwell, vol. i. p. 401. From an inscription cited by Spon we learn that Cœle belonged to the tribe Hippothoontis, *Itin.* tom. ii. p. 426.

⁵ Plutarch in *Them.*; Tzetz. *Chil.* viii. *Hist.* 192, v. 326; Philostr. *Sophist.* ii.; Tertull. *de Anim.* cap. 20; Xenoph. *Hell.* v. i. 23; Æsch. *Epist. ad Ctes.* Harpocr. v. *Ισχυαδρος*.

Athens. Eridanus of Pausanias. The fountain of Callirrhoe or Enneacrunus supplied the only spring water used by the Athenians, that of the other wells being either salt or brackish. According to Thucydides, it was situated on the south side of the city, close to the temples of Bacchus and Jupiter Olympius; but other authors affirm that it rose near the stream of the Ilissus; and here, in fact, Spon and Wheler observed a fountain, a little below the south-eastern angle of the Olympeum, to which the natives still applied the name of Kalliroi. Colonel Leake says that it now forms a pool, which in the drought of summer becomes muddy and scanty, but which is still resorted to as the only place in the neighbourhood furnishing sweet water.¹

Odeium,
Eleusini-
um, &c.

Near the fountain of Callirrhoe or Enneacrunus stood an Odeium (which the reader will be careful to distinguish from that of Pericles, formerly mentioned), adorned with various statues of the Egyptian Ptolemies, as well as of Philip, Alexander, Lysimachus, and Pyrrhus, and probably erected by some prince of the Macedonian dynasty. This seems to have been a sort of minor theatre, intended for recitation and music without action. In Agræ, the south-eastern suburb of Athens, and on the left bank of the Ilissus, a little above Enneacrunus, was the Eleusinium, or temple of Ceres and Proserpine, set apart for the celebration of the lesser Eleusinian mysteries. It is conjectured to have stood in an island between the Stadium and Olympeum, formed by the diverging torrents of the Ilissus, which seems well adapted for a place that was closed and kept sacred from the vulgar, and where the foundations of an ancient building are still observable. Plutarch informs us that the Stadium was erected by Lycurgus the son of Lycophron, for the celebration of games during the great Panathenaic festival. Pausanias describes it as an astonishing structure, rising in the shape of an amphitheatre above the Ilissus, and extending to the banks of that stream. It was originally constructed about the year 350 B. C. for the purpose just mentioned; and about five centuries afterwards it was covered with seats of Pentelic marble by Herodes Atticus, who is said to have been interred within its walls. The marble seats have all disappeared, but the entire cavea remains, together with the masses of masonry by which the semicircular end on the south was formed out of the torrent-bed of the Ilissus; and similar ruins are also observable at the opposite end, with the piers of a bridge over the Ilissus, and the site of a building on the summit of either hill. The temple of Triptolemus, which Pausanias also places above Enneacrunus, was probably the beautiful little Ionic building which the drawings of Stuart have preserved from oblivion. It formed in his time the church of Panagia on the Rock, but has now almost entirely disappeared. Travellers have sometimes taken this building for the Eleusinium; but it is scarcely credible that the edifice where the sacred mysteries of Ceres were celebrated should have been of so small dimensions.²

Lycerum.

Higher up the river was Agræ, containing the temple of Diana Agrotera, an altar dedicated to Boreas, and another sacred to the Musæ Ilissides. In the vicinity, too, were some gardens, and a temple of Venus celebrated for a statue of the goddess, executed by Alcamenes, a pupil of Phidias. But the most interesting spot in this quarter was the Lyceium, a sacred inclosure dedicated to Apollo Lycius, where the polemarch originally held his court. It

was decorated with fountains, plantations, and ornamental edifices by Peisistratus, Pericles, and Lycurgus, and became the usual place of exercise for such of the Athenian youth as devoted themselves to military pursuits. Nor was it less frequented by philosophers and others addicted to retirement and study. The Lyceium is indissolubly associated with the immortal name of Aristotle, who delivered his prelections, esoteric as well as exoteric, while walking within its sacred inclosure, and whose followers, thence called peripatetics, have added to the celebrity of the spot which formed the favourite resort of the greatest philosopher of the ancient world. The position commonly assigned to the Lyceium is on the right bank of the Ilissus, nearly opposite to the church of Petros Stauromenos, which is supposed to correspond with the temple of Diana Agrotera, on the other side of the river.³

Cynosarges was a spot consecrated to Hercules, and Cynosarges possessed a gymnasium, with groves frequented by the philosophers, as well as a sort of consistorial tribunal for deciding in all questions of legitimacy. After the battle of Marathon, when the city was threatened by the Persian fleet, which had doubled the promontory of Sunium (Cape Colonna), the Athenian army took up a position at Cynosarges, in order to cover the capital from attack, and to give battle to the enemy should they venture to land, which, however, they did not. Philip, the son of Demetrius, is said to have encamped on the same spot with a very different intention, and to have destroyed the groves and buildings around it, as well as those of the Lyceium. Cynosarges is supposed to have been situated at the foot of Mount Anchesmus, now the hill of St George, and to the southward of the place called Asomato.⁴

Beyond this hill, and outside the city walls, was the ex-Outer Ceramicus, of which we have already spoken incidentally. Here were interred Pericles, Phormio, Thrasybulus, and Chabrias; in this vast cemetery the bravest and the best men, who had proved themselves the ornaments of their country and the benefactors of their species, lay as it were in state beside that celebrated capital which their valour had defended or their genius illustrated; and, as far as the Academy, the road was lined on either side with the sepulchres of those Athenians who had fallen in battle. Over each tomb was placed a *stèle* or pillar, whereon were commemorated the names and tribes of the deceased. Among the several monuments enumerated by Pausanias we may notice those of the soldiers who fought at Tanagra before the Peloponnesian war, on the Euromedon under Cimon, at Potidæa under Callias, and at Amphipolis and Delium. One column commemorated the names of those who had fallen in Sicily; that of Nicias, however, was excepted, in consequence of his having surrendered to the enemy; while, on the other hand, Demosthenes was adjudged worthy of having his name inscribed, because, although he had capitulated for his army, he refused to be included individually in the treaty, and made an attempt on his own life. Here, also, were the cenotaphs of those who fell in the naval combat on the Hellespont, at the battle of Chæroneia, and in the course of the Lamiac war: here rose the tombs of Cleisthenes, who increased the number of the Attic tribes, of Tolmides, of Conon and Timotheus, whose exploits were only surpassed by those of Miltiades and Cimon: and here rested from their labours, in honoured repose, Zeno and Chrysippus, Harmodius and Aristogeiton, Ephialtes and

¹ Plat. *Phædr.* p. 229; Leake's *Topogr.* p. 49; Wheler's *Travels*, p. 376; Spon, tom. ii. p. 122.

² Pausan. *Attic.* 14 and 19; Philostr. *Vit. Herod.*; Stuart, *Antiq. of Athens*, iii. 5; Leake, 116.

³ Diog. Laert. *Vit. Aristot.*; Steph.; Leake, p. 150.

⁴ Pausan. *Attic.* 29; Plutarch, *Vit. Lycurg.* in *Dec. Rhet.*; Leake, p. 150.

Athens. Lycurgus, besides many others whom it would be tedious to enumerate. The games called Lampadephoria were celebrated in the outer Ceramicus.¹

Academy. The Academy (of which we have already spoken under that head) was situated at the extremity of this cemetery, about six stadia from the gate Dipylum. It was originally a deserted and unhealthy spot; but it was afterwards surrounded with a wall built at a great expense by Hipparchus, and it was planted, divided into walks, and supplied with fountains of water, by Cimon. Before the entrance was an altar of love; within was a temenos of Minerva, containing a temple of Prometheus, with an altar in the vestibule, whereon were figured in relief Vulcan and Prometheus, and whence also the race of the Lampadephoria usually commenced. Here likewise was a sanctuary of the Muses, built by Xenophon, containing statues of the Graces, dedicated by his disciple Speusippus, and a statue of Plato by Silanion, dedicated by Mithridates, a Persian. The Academy had likewise altars of Hermes, of Hercules, and of Jupiter Catæbates, also surnamed Morius, from the sacred olives called *moræ*, which grew near the sanctuary of Minerva; and contained the garden of Attalus, where the sophist Lacydes had his school, besides a *βοσχος* or tank, and some magnificent plane-trees of unusual height and size, which the Roman barbarian Sylla caused to be cut down during the siege of Athens. The modern name of Apathymia leads the traveller directly to this once favourite haunt of philosophers and poets; where the divine spirit of Plato poured forth its lofty fancies and sublime speculations in a stream of eloquence which the gods themselves might envy; where genius was married to science, and poetry to philosophy; and where the foundations were laid of a school which was destined to exert a powerful and (we may add) permanent influence on the opinions of mankind. But the name is the only memorial that remains of the Academy. "It is now," says Mr Hawkins, "an open piece of ground, not exceeding five acres, and presents nothing remarkable in its appearance. A few scattered olives grow on it; and some paces farther west we saw a number of gardens and vineyards, which contained fruit trees of a more exuberant growth than in any other part of the plain."²

Long Walls.

We have already had occasion to allude generally to the fortifications of Athens, including the celebrated Long Walls which connected the city with its several ports. The latter were first planned and commenced by Themistocles, after the termination of the Persian war; evidently with the intention of preventing any future invader from intercepting the communication between the city and the Peiræus, and thus starving the former into submission. But the hero of Salamis did not live to execute this great undertaking, which was continued after his death by Cimon, and finally completed by Pericles. These walls, which were deservedly considered by the ancients as one of the greatest objects of curiosity at Athens, were flanked at intervals with towers, some traces of which are still to be seen, and, together with a portion of the walls of the Asty and of the Peiræus at either end, formed an inclosure, which constituted one of the three great garrisons into which Athens was divided, and which, in this light, was sometimes denominated the long fortress (*το μακρον τευχος*). They were designated by the names Peiraic and Phaleric; the Peiraic or northern rampart (*βορειον τευχος*) measuring 40 stadia, and the Phaleric or southern rampart 35 stadia in length. From an expression of Plato, quoted by Harpocration (*διαμεσου τευχος*), it has been supposed that there was a

third or intermediate wall; but this is evidently an error, originating in a total mistake respecting the import of the term (*διαμεσου*) as applied by the philosopher, who uses the word, not in allusion to a wall interposed between the Peiraic and Phaleric ramparts, which indeed would be a great absurdity, but with reference solely to the whole of the long fortress (*μακρον τευχος*) situated between Athens and the maritime city. The long walls remained entire for about fifty-four years after their completion; that is, until the capture of Athens by the Peloponnesian forces, when they were dismantled and much injured; but eleven years subsequent to this disaster they were rebuilt by Conon, with the assistance of Pharnabazus, and the interior as well as the exterior rampart was guarded at intervals by towers and other defences. In the siege of Athens by Sylla, however, they were again broken down, and almost entirely destroyed. With regard to the existing remains, "they are chiefly remarkable," says Colonel Leake, "towards the lower end, where they were connected with the fortifications of Peiræus and Phalerum. The modern road from Athens to the port Drako, at something less than two miles short of the latter, comes upon the foundations of the northern long wall, which are formed of vast masses of squared stones, and are about twelve feet in thickness. Precisely parallel to it, at the distance of 550 feet, are seen the foundations of the southern long wall; the two thus forming a wide street running from the centre of the Phaleric hill, exactly in the direction of the entrance of the Acropolis."³

Maritime Athens. was divided into three districts and as many havens or ports; namely, Peiræus, Munychia, and Phalerum. From the earliest times Peiræus was a demus; but it did not become a harbour for ships until the administration of Themistocles; for hitherto Phalerum had been the usual port, as it was nearest the sea. The harbour of Peiræus was subdivided into three lesser havens, named Cantharus, Aphrodisium, and Zea. The first was appropriated as a dock-yard for the construction and repair of ships of war; the second seems to have been the middle or principal port; and the third, which was the outermost, appears from its name to have contained the granaries in which the Athenians deposited the corn imported from the countries on the Hellespont and other places for the supply of the capital. The most remarkable edifices and sites in the Peiræus were the maritime bazaar or emporium called Macra Stoa, consisting of five porticoes, so connected together as to form in fact only one grand or long portico; the market-place, called Hippodameia; the Deigma or exchange; the Serangium or public bath; the Phreatys or court of criminal justice, with a sort of admiralty jurisdiction; a theatre, of which some remains are still to be seen; and, lastly, the tomb of Themistocles. The Peiræus is now known by the name of Port Drako or Leone, from a colossal figure of a lion which once stood upon the beach, but was removed by the Venetians in the year 1687. The port of Munychia, so called, it is said, from Munychusan Orchomenian, was situated at the outer extremity of a promontory or narrow neck of land, at no great distance from the Peiræus. Strong by nature, Munychia, when inclosed within fortified lines connecting it with the other harbours, became a most important position, from the security it afforded to the maritime dependencies of Athens; and accordingly we find it always mentioned as the point which was most particularly guarded when any attack was apprehended on the seaward side. This port, which is nearly circular,

¹ Leake, *Topography of Athens*, 290.

² Leake's *Topography of Athens*, p. 351. See also p. 354 and 357.

³ *Topography of Athens*, in Walpole's *Mem.* vol. i. p. 488, note.

Athens. is known to the Greeks of the present day by the name of Stratioki. Phalerum, the most ancient of the Athenian ports, ceased to be of any importance in a maritime point of view, after the erection of the docks in the Peiræus; but it was nevertheless inclosed within the fortifications of Themistocles, and, as we have already seen, gave its name to the southernmost of the long walls, by means of which it was connected with Athens. Its modern name is Porto Fanari.¹

Having thus completed the description of Athens, with its suburbs and dependencies, all that now remains to be done is to notice a few of the most remarkable epochs in its history, and to conclude with some account of the modern town, collected from the most recent authorities.

History of the city. The history of Athens, from the death of Alexander to the present time, may be compressed within comparatively narrow limits. Soon after the premature decease of the Macedonian hero the citizens revolted; but they were defeated by Antipater, who garrisoned Munychia. Another insurrection followed with no better success. The garrison and oligarchy were reinstated; Demetrius, surnamed the Phalerean, was appointed governor of the city; and no less than three hundred statues were erected in honour of this man, by the degenerate descendants of those Athenians who had thought a place in the foreground of a picture, painted at the public expense, an adequate reward for the victory of Marathon. But Demetrius, surnamed Poliorcetes, "the shame of Greece in peace, her thunderbolt in war," withdrew the garrison, and restored the democracy; a service for which he was deified by the Athenians, who assigned him a residence in the opisthodomos of the Parthenon, as a guest worthy of being entertained by Minerva herself, and afterwards placed the Peiræus, with Munychia, at his disposal. As usual, however, they soon became weary of their idol, expelled his garrison, and regained their independence; chiefly, as is said, by the intercession of Craterus the philosopher, who persuaded Demetrius to leave them in possession of their liberty. Antigonos Gonatas, the next king of Macedonia, proved less scrupulous than "the Taker of Cities," and again seized upon Athens, where he established a garrison. But, on the death of Demetrius, son of Gonatas, the people, aided by Aratus, recovered their liberty; and the Peiræus, Munychia, Salamis, and Sunium, were restored to them, on payment of a considerable sum of money by way of equivalent. Disregarding this arrangement, however, Philip, the son of Demetrius, invaded Attica, and, encamping near the city, burned and destroyed the sepulchres and temples in the villages, slaughtered the inhabitants, and laid waste the greater part of the country.

Driven to despair by these barbarous proceedings, the Athenians were forced to solicit the protection of the Romans, which was readily granted, and to receive a garrison into the citadel, which it continued to occupy until the war with Mithridates, king of Pontus. But, taking advantage of the embarrassments of Rome, occasioned by one of the most arduous contests in which she had yet engaged, the Athenians, at the instigation of Aristion, general of the royal linguist, rose upon their protectors and expelled the garrison. This act of ingratitude met with an exemplary punishment. War was immediately declared; and Sylla soon afterwards appeared in Attica at the head of a powerful

army. Unable to withstand the fury of the Romans, Archelaus, the Athenian general, relinquished the defence of the long walls, and retired into the Peiræus and Munychia. Sylla, on the other hand, immediately laid siege to the Peiræus, as well as to the city itself where Aristion commanded; and having received information that some persons had been overheard conversing in the Ceramicus, and blaming Aristion for his neglect of the avenues near the Hep-tachalcos, where the wall was accessible, he instantly resolved to assault the town in that quarter. Accordingly, about midnight he entered the city by the gate Dipylum, which he forced, and, having overcome every obstacle between it and the Peiraic gate, was soon master of Athens. Aristion fled to the Acropolis; but being at length compelled to surrender from want of water, the supply of which had been cut off, he was dragged from the sanctuary of Minerva, where he had sought refuge, and instantly put to death. This event took place in the year of Rome 607, or about 140 years before the Christian era. Sylla raged against the unfortunate city with the fury of a barbarian; burning the Peiræus and Munychia, defacing the monuments in the town and suburbs, and not even sparing the sepulchres of the dead in the Ceramicus.

In the civil war between Cæsar and Pompey, the Athenians declared for the champion of liberty. But although the battle of Pharsalia placed them at the mercy of Cæsar, that great and generous conqueror, "whose brow was girt with laurels more than hair," scorned to sully the lustre of his renown by any act of vengeance, and, with a magnanimity native to his character, dismissed the envoys who had been sent to propitiate him, with this fine observation: "I am content to spare the living for the sake of the dead." The same lingering affection for liberty which had led the Athenians to side with Pompey, also induced them to take part with Brutus and Cassius, in the wars of the second triumvirate; and they had even the spirit to erect statues to the two Roman patriots, beside those of their own deliverers, Harmodius and Aristogeiton. But at Philippi, as at Pharsalia, the gods declared against liberty,² and the Athenians were again on the losing side. Nor were they more fortunate in the contest which ensued between Octavius and Antony; for having joined the latter, who gave them Ægina, Cea, and other islands, they incurred the resentment of Augustus, now become master of the Roman world, who treated them with the utmost harshness and severity. Under Tiberius the city declined; but it still continued to enjoy a considerable share of freedom, and was regarded as an ally of the Romans. Germanicus conferred upon it the privilege of having a lictor to precede the magistrates; but he was censured for this act of condescension, as "the race of noble bloods" was now believed to be extinct, and the Athenian people a mixture of all nations. The emperor Vespasian reduced Achaia into the form of a province, and gave it a proconsular government. But Nerva proved more indulgent to Athens; and under his successor, Trajan, Pliny exhorted Maximus, when intrusted with the government, to be mindful of the ancient glory of that classic land, and to rule Greece as if it had still been composed of free cities.³ Hadrian, prouder of the archonship of Athens than of his imperial dignity, gave the city a digest of laws compiled from the codes of Draco, Solon, and other legislators, and testified his af-

Athens.

¹ For a full and accurate account of the present state of the Peiræus and its adjoining ports see Colonel Leake's work, p. 312, 325, and 326.

² The fine, though somewhat irreverent, sentiment expressed in the following line of Lucan, is not altogether inapplicable here:—

"Victrix caussa diis placuit, sed victa Catoni."

³ "You will revere the gods and heroes their founders," said he; "you will respect their pristine glory, and even their age; you will honour them for the famous deeds which are truly, and even for those which are fabulously, recorded of them: remember it is Athens you approach."

Athens. fection for it by unbounded munificence. Antoninus Pius, who succeeded Hadrian, and Antoninus the philosopher, also proved themselves benefactors of Athens, though on a less magnificent scale than their predecessor.

In the reign of Valerian, the northern barbarians first appeared in Asia Minor, where they laid siege to Thessalonica. This extraordinary apparition having alarmed all Greece, the Athenians restored their city wall, which Sylla had dismantled, and otherwise placed the town in a state of defence sufficient to secure it against a *coup-de-main*. But under Gallienus, the next emperor, Athens was besieged, and the archonship abolished; upon which the strategus or general, who had previously acted as inspector of the Agora, became the chief magistrate. Under Claudius the city was taken, but recovered soon afterwards. Constantine the Great gloried in the title of General of Athens, which had been conferred upon him, and expressed high satisfaction on obtaining from the people the honour of a statue with an inscription; a distinction which he acknowledged by sending to the city a yearly gratuity of grain. He also conferred on the governor of Attica and Athens the title of *Μεγας Δουξ*, or Grand Duke, which soon became hereditary; and his son Constans bestowed several islands on the city, in order to supply it with corn. In the time of Theodosius I., that is, towards the end of the fourth century, the Goths laid waste Thessaly and Epirus; but Theodorus, general of the Achæans, acted with so much prudence that he saved the Greek cities from pillage and the inhabitants from captivity; a service which was most gratefully acknowledged. But this deliverance proved only temporary. The fatal period was now fast approaching; and, in a real barbarian, Athens was doomed to experience a conqueror yet more savage and remorseless than Sylla. This was Alaric, king of the Goths, who, under the emperors Arcadius and Honorius, overran both Italy and Greece; sacking, pillaging, and destroying. Never indeed did the fury even of barbarian conquest discharge itself in a fiercer or more desolating tempest. The Peloponnesian cities were overturned; Arcadia and Lacedæmon were both laid waste; the gulfs of Lepanto and Ægina were illuminated with the flames of Corinth; and the Athenian matrons were dragged in chains to satisfy the brutal desires of these rampant barbarians. The invaluable treasures of antiquity were removed; stately and magnificent structures were reduced to heaps of ruin; and Athens, stripped of the monuments of her ancient splendour, was compared by Synesius, a writer of that age, to a victim of which the body had been consumed, and the skin only remained.

After this dreadful visitation Athens sank into insignificance, and became as obscure as it had once been illustrious. We are indeed informed that the cities of Hellas were put in a state of defence by Justinian, who repaired the walls of Corinth, which had been overturned by an earthquake, and those of Athens, which had fallen into decay through age. But from the time of this emperor a chasm of nearly seven centuries ensues in its history; except that, about the year 1130, it furnished Roger, the first king of Sicily, with a number of artificers, who there introduced the culture of silk, which afterwards passed into Italy. The worms, it seems, had been brought from India to Constantinople in the reign of Justinian.

Doomed apparently to become the prey of every spoiler, Athens again emerges from oblivion in the thirteenth century, under Baldwin and his crusaders, at a time when it was besieged by a general of Theodorus Lascaris, the

Greek emperor. In 1427 it was taken by Sultan Murad; Athens. but some time afterwards it was recovered from the infidels by another body of crusaders, under the marquis of Montferrat, a powerful baron of the West, who bestowed it, along with Thebes, on Otho de la Roche, one of his principal followers. For a considerable time both cities were governed by Otho and his descendants, with the title of dukes; but being unable to maintain themselves in their Greek principality, they were at length succeeded by Walter of Brienne, who, soon after his succession, was expelled by his new subjects, aided by the Spaniards of Catalonia. The next rulers of Athens were the Acciaïoli, an opulent family of Florence, in whose possession it remained until 1455, when it was taken by Omar, a general of Mahommed II., and thus fell a second time into the hands of the barbarians. The victorious sultan settled a Mahomedan colony in his new conquest, which he incorporated with the Ottoman empire; and Athens, as well as Greece, continued to form an integral part of the Turkish dominions, until the treaty of Adrianople in 1829, following up the provisions and stipulations of the treaty of London, 7th July 1827, established the new state of Greece within limits which, though not definitively fixed, are understood to include the ancient capital of Attica.

From the period of the Ottoman conquest to the commencement of the insurrection in 1821, Athens was only known in history by two attempts, on the part of the Venetians, to expel the Turks and make themselves masters of the city. The first of these took place in 1464, only nine years after its capture by the Osmanlees, and proved an entire failure. But the second, which was undertaken in 1687, more than two centuries later, was crowned with a temporary and fatal success. In the month of September of that year, Count Königsmarck, a Swede in the service of Venice, having disembarked at the Peiræus a force of 8000 foot and 870 horse, forming part of the armament under Francesco Morosini, afterwards doge, marched to Athens; and having summoned the citadel without effect, he erected a battery of heavy ordnance on the hill of the Pnyx, and placing two mortars near the Latin convent at the western foot of the Acropolis, bombarded it for several days. The fire of the cannon was chiefly directed against the Propylæa, and the modern defences below that edifice; whilst the mortars continued, without intermission, to throw shells into the citadel. The consequence was, that the beautiful little temple of Victory without wings, the frieze of which is now in the British Museum, was completely destroyed by the breaching battery; and the Parthenon, besides being greatly injured by the bursting of the shells, was, towards the close of the attack, almost rent in pieces by the explosion of a powder magazine, which reduced the middle of the temple to a heap of ruins, threw down the whole of the wall at the eastern extremity, and precipitated to the ground every statue on the eastern pediment. The western extremity was fortunately less injured, and a part of the opisthodomos was still left standing, together with some of the lateral columns of the peristyle adjoining to the cell. But the shock was nevertheless abundantly disastrous; and when the Turks afterwards regained possession of the citadel (from which, on this occasion, they were expelled), they did all in their power to complete the destruction which the Venetians had so vigorously begun, by defacing, mutilating, or burning for lime every fragment of the edifice within their reach.¹

In the course of the late revolutionary war, Athens sus-

¹ It has been often remarked of the Turks that they are encamped rather than settled in Europe. Far from improving the countries they govern, they scathe every thing that comes within their reach; they destroy monuments, but build none; and when at length they are driven out by the chances of war or revolution, the only traces they leave of their sway are to be found in the deso-

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tained three sieges. The first was laid by the Greeks in 1822. Having carried the town by storm, and driven the Turks into the citadel, they established a strict blockade of the fortress, which was continued until the advance of the pasha at the head of 4000 men induced them to abandon their enterprise, and fly, with the Athenians, to Salamis and Ægina. Two months afterwards, the pasha having left Athens to the defence of 1500 men, the Greeks again ventured to attack the town, and succeeded in obliging the Turks to seek refuge in the citadel, which they forthwith determined to besiege; but, from ignorance and want of means, no progress whatever was made in the operation, until they obtained possession of the well which supplied the garrison with water, when the Turks agreed to capitulate, upon condition of being immediately embarked with their families, and sent to Asia Minor. On various pretences, however, the embarkation was delayed from time to time; and when intelligence at length arrived that a large Turkish force was advancing upon Athens, the Palicari, instead of manning the walls and preparing for a vigorous defence, rushed in a body to the houses where the prisoners were confined, and commenced an indiscriminate massacre, in which the young and beautiful inmates of the harem, the aged and infirm, and the brave but defenceless spahis and janissaries, fell alike beneath the merciless yataghan. This atrocity, for which no possible palliation can be alleged, and which, in every circumstance of cruelty, exceeded that previously perpetrated at Tripolizza, reflects indelible dishonour on the Greek character, and proves that they inherit the faithlessness of their ancestors, with the innate ferocity of their former masters. The third siege was laid by the Turks in 1826. The Greeks had left a strong garrison in the Acropolis, with provisions for several months; and a spring of water having been discovered in the cave of Pan, and inclosed by Odysseus within the defences of the citadel, there was no danger of its being starved into a surrender. But the Turks having established batteries near the Pnyx and on the hill of the Museum, and having drawn a line of trenches round the citadel, with the view of intercepting all communication between the besieged and the Greek army, the garrison was hard pressed; and although Colonel Fabvier succeeded in forcing his way through the Turkish lines with 500 men and a supply of ammunition, and thus affording immediate relief, yet the total defeat of the Greek army under General Church, at the battle of Athens, fought in the hope of raising the siege, led soon after to the surrender of the Acropolis, which remained in the hands of the Turks until the termination of the revolutionary war.

We have no means of ascertaining the extent of the additional damage done to the remaining monuments of the Acropolis during these various operations. Pouqueville, speaking of the siege of 1822, says, "Les monumens sont restés intacts par un de ces hazards qu'on ne peut

expliquer."¹ But even if this were true of the siege in question, which we do not believe it is, there is too much reason to fear that the succeeding one, which terminated in restoring to the Turks their ancient possession, after a battle and a victory, was attended with the destruction of every thing within the reach of the infuriated Osmanlees. Hence we cannot help felicitating ourselves that so many of the most precious remains of Grecian art and antiquity had been rescued from every hazard, and deposited in a secure asylum, long before the commencement of the late troubles. For this we are indebted to the earl of Elgin, who, while British ambassador at Constantinople, made that invaluable collection, which has since become the property of the nation, though it is still most deservedly known by the name of the noble collector.

The modern town of Athens (now called by the various Modern names of Athene, Athinia, and Setines), was a small open town. place, with extremely narrow and irregular streets. The houses were for the most part mean and straggling; many of them had large courts or areas in front; and in the lanes, the high walls on either side, which were commonly whitewashed, reflected strongly the heat of the sun, and thus added to the discomfort of the place. But it is now little better than a heap of rubbish; and it is even doubted whether an attempt will be made to rebuild on the same site, especially as the ground to the westward of the walls presents a more desirable position. The population has been variously estimated by travellers. Dr Clarke supposes it to have amounted in his time to about 15,000 souls. When Mr Hobhouse visited Athens, at a later period, it contained 1200 or 1300 houses, of which 300 were occupied by Albanians, 400 by Turks, and 500 or 600 by Greeks; and if we allow ten persons for each house, its population, at this time, must consequently have amounted to 12,000 or 13,000, divided, or rather classed, in the proportions just mentioned. Other travellers, again, think that it did not exceed from 8000 to 10,000 souls; an estimate which, considering recent events, and the necessary removal of a great many Turkish families, must still be greatly beyond the truth as applicable to the present time. Of mosques, churches, and chapels of all sorts, there were nearly two hundred; but how many or how few of these remain it is impossible to say. The modern town lies chiefly on the north and north-west side of the Acropolis, and is completely commanded by the fortress. The harbour of the Peiræus is now almost entirely desolate, not a single house being near it except a miserable hut called a custom-house; but outside the port, about two miles to the westward, is a good roadstead, with nearly eighteen fathoms water. It is still frequented, however, by a few English and French vessels of small size, which occasionally resort thither to trade in oil, the staple production of Attica. The modern Athenians also carry on some little traffic in wool, silk, wax, olives, honey, and a few other articles. (A.)

ATHEROMA, in *Surgery*, an encysted tumour, containing a soft substance, resembling pap, intermixed with hard and stony particles.

ATHERSTONE, a market town of the hundred of Hemlingford, in the county of Warwick, 109 miles from London. It has the benefit of the Coventry canal, which passes

near the town, and some trade in ribbons, woollen stuffs, and hats. The market is on Tuesday. Population in 1801, 2650; in 1811, 2921; and in 1821, 3434 inhabitants.

ATHERTON, or **CHOWBENT**, a township in the parish of Leigh, and hundred of West Derby, in Lancashire, 199 miles from London. It is one of those places which has

lation with which they everywhere encompass themselves. They may be compared to a flight of locusts eating up and destroying whatever they alight upon; conferring no benefits in return; and at last, when swept from the face of the earth by some kindly blast, only remembered from the havoc they had committed.

¹ *Histoire de la Régénération de la Grèce, comprenant le précis des Evénemens depuis 1740 jusqu'en 1824.* Par F. C. H. L. Pouqueville, tome iii. p. 556.

Athletæ
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Athos.

grown to wealth and populousness since the extension of the cotton trade. Population in 1801, 3249; in 1811, 3894; and in 1821, 4145.

ATHLETÆ, in *Antiquity*, persons of strength and agility, disciplined to perform in the public games. The word is originally Greek, ἀθλητής, formed from ἀθλος, *certamen*, combat; whence also, ἀθλον, the prize or reward adjudged to the victor. Under athletæ were comprehended wrestlers, boxers, runners, leapers, throwers of the disk, and those practised in other exercises exhibited in the Olympic, Pythian, and other solemn sports.

ATHLONE, a market town in Ireland, lying partly in Westmeath, and partly in Connaught. It is situated on the river Shannon, by which it is intersected, the opposite sides being connected by an ancient stone bridge. This afforded the principal passage over the river; and hence, in the war of 1688, the possession of the town was considered of vital importance. Accordingly, it underwent two sieges, the first by William III. in person, which failed; and the second by General Ginkle, who, in the face of the Irish, forded the river, and took possession of the town, not losing more than fifty men in the attack. At present it is one of the principal depots for arms and military stores, and quarters a large garrison, upon the expenditure of which the town chiefly depends. Distant 55 miles west of Dublin. Long. 7. 50. W. Lat. 53. 20. N.

ATHOL, the most northern district of Perthshire, in Scotland, extending about 45 miles in length by 40 in breadth. It is bordered on the north by Badenoch, on the west by Lochaber, on the east and south-east by Mar and Gowrie, on the south by Stratherne and Perth Proper, and on the south-west by Breadalbane. This district is rough and mountainous, interspersed with woods and valleys, but withal beautiful and romantic. In Blair, amidst a wilderness of old trees, stands Blair Castle, the principal seat of the duke of Athol. In the same neighbourhood is situated the pass of Killicranky, memorable as being the scene of action between the troops of William III. under General M'Kay, and the highland adherents of James II. under the celebrated Viscount Dundee. Athol possesses a few villages; but it is destitute of towns of any importance.

ATHOS, a celebrated mountain of Chalcidia, in Macedonia, situated in long. 26. 20. E. and lat. 40. 10. N. The ancients entertained extravagant notions concerning its height. On many accounts it was famous amongst them, but it is no less so among the moderns. The Greeks, struck with its singular situation, and the venerable appearance of its towering ascent, rising as it does in the form of an isolated pyramid, erected so many churches, monasteries, hermitages, &c. upon it, that it became in a manner inhabited by devotees, and from thence received the name of the *Holy Mountain*, which it still retains, though many of those consecrated abodes are now decayed. This mountain advances into the Archipelago, being joined to the continent by an isthmus about half a league in breadth. It is 3353 feet in height, about 30 miles in circumference, and may be seen 90 miles off. It abounds with many different kinds of plants and trees, particularly the pine and fir. The appearance of the mountain at present is exceedingly interesting. Upon its sides there is scattered a profusion of convents, chapels, villages, cells, and grotts, inhabited by a number of monks of various countries, who never marry, and subsist on the most penitential fare. They are very industrious, cultivating the vine and the olive in the field, and practising various mechanical arts in their secluded abodes. The researches of Professor Carlyle for some years have at length completely dissipated the expectations long indulged of finding valuable manuscripts in these monasteries.

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Through this mountain, or rather through the isthmus behind it, Xerxes, king of Persia, is said to have cut a passage for his fleet when about to invade Greece. In this work he spent three whole years, employing all the forces on board his fleet. The truth of such a canal being cut was long denied, but has at length been proved. Its remains were distinctly seen by Dr Sibthorp, partly filled with water. (See Walpole's *Memoirs relating to Turkey*, 1817.)

ATHY, a town of Ireland, in the county of Kildare, intersected by the river Barrow, which is there navigable. The county assizes are held at this place and Naas alternately. Distant 32 miles S. W. of Dublin. Long. 7. 1. W. Lat. 52. 19. N.

ATIENZA, a town of Spain, in the southern division of the province of Sorea. It is on the declivity of a hill, contains five churches, a monastery, and 1950 inhabitants. Near to it are several salt springs, which are boiled in three villages in the neighbourhood.

ATKINS, SIR ROBERT, lord chief baron of the exchequer, was born in 1621, and educated at the university of Oxford, from whence he removed to the inns of court, and became eminent in the law. He was made knight of the bath, with many other persons of the first distinction, at the coronation of King Charles II. In 1672 he was appointed one of the judges of common pleas, in which honourable station he continued till 1679, when, foreseeing the troubles that soon afterwards ensued, he resigned his office, and retired into the country. In 1689 he was made lord chief baron of the exchequer by King William; and about the same time held the office of speaker to the house of lords, which had been previously refused by the marquis of Halifax. He distinguished himself by an unshaken zeal for the laws and liberties of his country. He wrote several pieces, which have been collected into an octavo volume, under the title of *Parliamentary and Political Tracts*. It has been remarked, that whoever wishes thorough information on the true constitution of his country, on the grounds and reasons of the revolution, and on the danger of suffering prerogative to jostle law, cannot read a better or plainer book than those tracts. He died in 1709, aged 88.

ATKINS, SIR ROBERT, son of the preceding, was born in 1646. He wrote *The Ancient and Present State of Gloucestershire*, in one large folio volume. He died October 29, 1711.

ATKYNS, RICHARD, was born of a good family at Tuffleigh, in Gloucestershire, in the year 1615. He was educated at Oxford, from whence he removed to Lincoln's inn. During the civil wars he distinguished himself by his loyalty to King Charles I., and raised for him a troop of horse at his own expense. At the restoration he was made one of the deputy-lieutenants of Gloucestershire, and was remarkable for his attachment to the government. But at length being committed prisoner to the Marshalsea, in Southwark, for debt, he died there on the 14th of September 1677. He wrote several pieces, particularly a treatise *On the Original and Growth of Printing*.

ATLANTIC OCEAN, that sea which is bounded by Europe and Africa on the east, and by America on the west.

ATLANTIDES, in *Astronomy*, a denomination given to the Pleiades, or seven stars, sometimes also called *Ver-giliae*. They are thus called, as being supposed by the poets to have been the daughters either of Atlas or his brother Hesperus, who were translated into heaven.

ATLANTIS, ATALANTIS, or ATLANTICA, an island mentioned by Plato and some others of the ancients, concerning the real existence of which many disputes have been raised. Homer, Horace, and the other poets make

Atlas. two Atlanticas, calling them *Hesperides* and *Elysian Fields*, and representing them as the habitations of the blessed. The most distinct account of this island we have in Plato's *Timæus*, of which Mr Chambers gives the following abridgment:—"The Atlantis was a large island in the Western Ocean, situated before or opposite to the Straits of Gades. Out of this island there was an easy passage into some others, which lay near a large continent, exceeding in size all Europe and Asia. Neptune settled in this island (from whose son Atlas its name was derived), and divided it amongst his ten sons. To the youngest fell the extremity of the island, called *Gadir*, which, in the language of the country, signifies *fertile*, or *abundant in sheep*. The descendants of Neptune reigned here, from father to son, for a great number of generations, in the order of primogeniture, during the space of nine thousand years. They also possessed several other islands; and passing into Europe and Africa, they subdued all Libya as far as Egypt, and all Europe to Asia Minor. At length the island sunk under water; and for a long time afterwards the sea thereabouts was full of rocks and shelves." Many of the moderns also are of opinion that the existence of the Atlantis is not to be looked upon as entirely fabulous. Some take it to have been America; and on this supposition, as well as from a passage in Seneca's *Medea*, and other obscure hints, they imagine that the new world was not unknown to the ancients. But allowing this to be the case, the above-mentioned continent, which was said to lie beyond Atlantis, would seem rather to have been the continent of America than Atlantis itself. The learned Rudbeck, professor in the university of Upsal, in a work entitled *Atlantica sive Manheim*, endeavours to prove that Sweden and Norway are the Atlantis of the ancients; but the situation assigned to it renders this notion untenable. Kircher supposes it to have been an island extending from the Canaries quite to the Azores; adding, that it was really swallowed up by the ocean, as Plato asserts, and that these small islands are the shattered remains of it which were left standing.

ATLAS, king of Mauritania, a great astronomer, contemporary with Moses. From his taking observations of the stars on a mountain, the poets feigned him to have been turned into a mountain, and to sustain the heavens on his shoulders. Being an excellent astronomer, and the first who taught the doctrine of the sphere, they tell us that his daughters were turned into stars; seven of them forming the Pleiades, and other seven the Hyades.

ATLAS, a chain of mountains in Africa, lying between the 20th and 25th degrees of north latitude, and supposed almost to divide the continent from east to west. They are said to have derived their name from Atlas, king of Mauritania. They are greatly celebrated by the ancients on account of their height, insomuch that the above-mentioned king, who is said to have been transformed into a mountain, was feigned to support the heavens on his shoulders. M. Desfontaines, who with the eyes of a learned botanist surveyed a great part of this system of mountains, considers it as divided into two leading chains. The southern one, adjoining the desert, is called the Great Atlas; the other, lying towards the Mediterranean, is called the Little Chain. Both run east and west in a parallel direction, and are connected together by several intermediate mountains running north and south, and containing between them both valleys and table-lands; but it is worthy of remark that the Great and Little Atlas of Ptolemy, the one of which is terminated at Cape Felueh, and the other at Cape Cautin, differ from the chains of the French traveller, being lateral branches which shoot off from the main system, to form promontories on the sea-coast. According to Dr Shaw, if we conceive a number of hills,

usually of the perpendicular height of 400, 500, or 600 yards, with an easy ascent, and several groves of fruit or forest trees, rising up in a succession of ranges above one another,—and if to this prospect we add now and then a rocky precipice, having generally a miserable mud-walled village on the summit,—we shall then have a just idea of the mountains of Atlas. The observations of Shaw, however, were confined to eastern Barbary, through which alone he travelled; but Jackson, and other later observers, who saw these mountains from Morocco, describe them as rising to the height of 12,000 or 13,000 feet, and, even in this tropical climate, having their summits covered with perpetual snow.

According to M. Chenier, they are formed by an endless chain of lofty eminences, inhabited by a multitude of tribes, whose ferocity permits no stranger to approach. "Nothing, perhaps," says he, "would be more interesting to the curiosity of the philosopher, or conduce more to the improvement of our knowledge in natural history, than a journey over Mount Atlas. The climate, though extremely cold in winter, is very healthy and pleasant; the valleys are well cultivated, abound in fruits, and are diversified by forests and plentiful springs, the streams of which uniting at a little distance, form considerable rivers, and lose themselves in the ocean. According to the reports of the Moors, there are many quarries of marble, granite, and other valuable stone, in these mountains." Lead, silver, and copper, are extracted from different parts of them. It is even reported, and Mr Jackson thinks with some truth, that gold and silver might be obtained in them, but for the jealousy of the sovereigns of Morocco. There is also a copious supply of antimony, an article in extensive demand throughout the surrounding countries as a cosmetic for tinging the eyebrows; and sulphur occurs abundantly in the south-eastern tract. The inhabitants are composed of the ancient race of the Berbers or Berebbers, who have always maintained a sort of savage independence.

ATLAS, in matters of literature, denotes a book of universal geography, containing maps of all the known parts of the world, or simply a collection of maps and charts.

ATMOMETER (from *ατμος*, *vapour*, and *μετρον*, *a measure*), an instrument contrived by Professor Leslie, for measuring the quantity of moisture exhaled from any humid surface in a given time. It consists of a very thin ball of porous earthenware, from one to three inches in diameter, having a small neck firmly cemented to a long and rather wide tube of glass, to which is adapted a brass cap, with a narrow collar of leather to fit close. Being filled with distilled or pure water, the waste and descent of this column serves to indicate the quantity of evaporation from the external surface of the ball. The tube is marked downwards, through its whole length, by the point of a diamond, with divisions across it, amounting to from 200 to 500, each of which corresponds to a ring of fluid, that, spread over the whole exhaling surface, would form a film only one thousandth part of an inch in thickness. This graduation is performed by previously sealing one of the ends of the tube with wax, and introducing successive portions of quicksilver, to mark every 20, 50, or 100 of those divisions; being calculated of equal bulk to disks of water, that have the surface of the ball (exclusive of the neck) for their base, and so many thousand parts of an inch for their altitude.

The instrument, being thus constructed, has its cavity filled with pure water, and its cap screwed tight, and is then suspended freely out of doors, sheltered indeed from rain, but exposed to the action of the wind. The water transudes through the porous substance of the ball just as fast as it evaporates from the external surface; and

Atlas
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Atmometer.

Atmome-
ter.

this waste is measured by the corresponding descent of the liquid in the stem. At the same time, the column is suspended in consequence of the tightness of the cap, and prevented from oozing so freely as to drop from the ball. As the process of evaporation goes on, minute globules of air, separated by the removal of atmospheric pressure from the body of the water, or partly introduced by external absorption, continue to rise in fine streamlets to the top, where they partially occupy the space left by the subsidence of the fluid column. We need scarcely observe, that, after the water has sunk to the bottom of the stem, it will be requisite again to fill the cavity.

It is a fact of main importance for the accuracy of the atmometer, that the rate of evaporation is nowise affected by the quality of the porous ball, and continues precisely the same whether the exhaling surface appears almost dry or glistens with excess of moisture. This rate must evidently depend on the effect of the dryness of the air combined with its quickness of circulation. In a close room the instrument might therefore serve the purpose of an hygrometer; and, placed out of doors, first screened, perhaps, for an hour, and then exposed during an equal space of time, it would furnish data for calculating the velocity of the wind.

This instrument is of extensive application and great practical utility. To ascertain readily and accurately the rate of evaporation from any surface, is an important acquisition, not only in meteorology, but in agriculture, and in the various mechanical arts. The quantity of exhalation from the surface of the ground is not of less consequence than the measure of the fall of rain, and a knowledge of it might often direct the farmer advantageously in his operations. On the rapid dispersion of moisture depends the efficacy of drying-houses, which are generally constructed on most erroneous principles.

The atmometer, in its most compendious form, is admirably fitted for delicate experiments on the evaporation which takes place in close vessels when absorbent substances are introduced. Let the ball of the instrument, for example, be immersed in air variously rarefied or condensed, under a receiver covering a surface of sulphuric acid which has different degrees of strength; and, things being thus disposed, on extracting the common air, and introducing hydrogen gas, the rate of evaporation will then be nearly tripled.

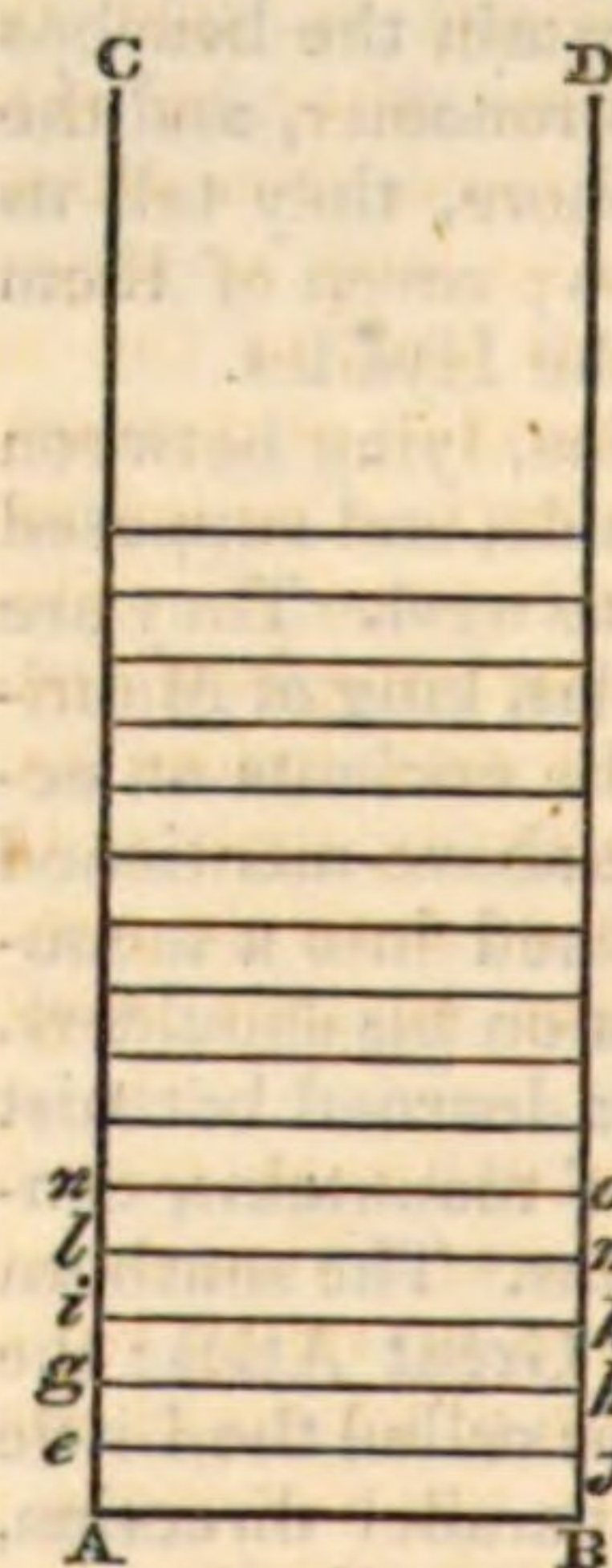
We shall close this notice with mentioning a striking fact, which shows the necessity of extreme caution in all physical inquiries. Let the ball of an atmometer be cemented to a narrow glass tube of three or four feet in length, and the whole capacity filled with fresh distilled water. Now invert the instrument upright in a basin of quicksilver, and secure it in that situation; the quicksilver, following the column of water, will rise at first quickly, and then by degrees more slowly, till it reaches, perhaps, an elevation of 28 inches, where it will remain stationary and afterwards sink down, when the evaporation is nearly spent. Ice-water is raised in this way about 26 inches only, and common water scarcely 24 inches; the air separated from such liquids forming near the top of the ball a thin medium, which, by its elasticity, counteracts in part the pressure of the external atmosphere supporting the mercurial column. But a similar experiment, where the shoot of a vine was cemented to a tube holding quicksilver, has been thought, by Dr Hales and M. Du Hamel, quite conclusive in proving the *power* of the living principle of vegetation. It is obvious that the force of evaporation alone was sufficient to explain the facts advanced by those ingenious philosophers. See METEOROLOGY.

ATMOSPHERE is the name applied to the invisible elastic medium which surrounds the globe of the earth to an unknown height. The fluid of which it is composed is usually distinguished by the name of *air*.

It is well known that the pressure of the atmosphere is the cause of the rise of the mercury in the barometer. Now the mean height of the barometer at the level of the sea is 29.82 inches. Hence it follows that the whole weight of the atmosphere is equal to that of a sphere of mercury covering the whole surface of the globe, and extending to the height of 29.82 inches. The specific gravity of mercury is 13.568, and a cubic inch of water at the temperature of 60° weighs very nearly 252.5 grains. Hence a cubic inch of mercury will weigh 3425.92 grains, or 0.48956 lb. avoirdupois; and a column of the atmosphere reaching from the surface of the earth to the utmost height to which that elastic fluid reaches, and whose base is a square inch, weighs about 14.6 lbs. avoirdupois, or exerts a pressure equal to 14.6 lbs. upon the earth or any substance on which it rests.

The atmosphere consists chiefly of *air*, an elastic fluid composed of a mixture of four volumes of azotic with one volume of oxygen gas. Now, from the most exact experiments hitherto made, it follows, that at the temperature of 60°, and under the mean pressure of the atmosphere, a cubic inch of air weighs 0.311446 grains. If, therefore, the air were everywhere of the same density, the height of the atmosphere above the surface of the earth would be 328,021 inches, or 27,335 feet, or 5.17 miles.

But air is an elastic fluid, the particles of which repel each other with a force varying inversely as the distance of the centres of the particles from each other. It is obvious, from this property of air, that its volume, and consequently its density, will depend upon the pressure. The greater the pressure, the smaller the volume. Those portions of the atmosphere that are in contact with the earth are pressed upon by the whole portion above them. The air at the top of a mountain is pressed upon by all the air above it; while all that portion below it, or lying between the top of the mountain and the surface of the sea, exerts no action on it whatever. This will be better understood by the following diagram. Let ABCD be conceived to be



a section of a vessel extending from the surface of the earth at AB to the limit of the atmosphere CD, and filled with air. Let this pillar of air be divided into an infinite number of equal sections, each exceedingly thin, by the planes *ef*, *gh*, *ih*, *lm*, *no*, &c. Since the density of air is always as the compressing force, it follows that the density of the stratum *ABef* is to that of the density of the stratum *efgh* as *efCD* to *ghCD*. So that the difference between the pressures on *ef* and *gh* is equal to the quantity of air *efgh*. For the same reason, the difference between the pressures on *gh* and *ih* is equal to the quantity of air *ghik*; and this ratio holds to the very limit of the atmosphere. Therefore the densities of air in these spaces are proportional to the quantities of which they themselves are the differences. Now, when there is a series of quantities whose terms are proportional to their own differences, both those quantities and their differences are in geometrical progression; therefore the densities of the strata of air *ABef*, *efgh*, *ghik*, *ikhm*, &c. are in geometrical progression.

It is equally obvious that the heights of these equal spaces above AB, the surface of the earth, are in arithme-

Atmo-
sphere.

Atmo- sphere. tical progression. If ef be 1 inch above the earth's surface, gh will be 2 inches, ik will be 3 inches, and so on. From all this we derive this remarkable conclusion, that *if the altitudes above the surface of the earth be taken in arithmetical progression, the densities of the air at these altitudes will be in geometrical progression decreasing.* If at a certain altitude above the earth's surface the density of the air be one half what it is at the surface of the earth, then at twice that altitude the density will be reduced to one fourth of the density at the earth's surface, and so on.

We can calculate the density of the atmosphere at all heights above the earth's surface very readily by means of a table of logarithms; for logarithms constitute a set of numbers in arithmetical progression annexed to another set of numbers which are in geometrical progression. If, therefore, we take logarithms to represent the heights, the numbers to which these logarithms are attached will represent the corresponding densities of the air. Suppose the density of the air at one mile above the surface of the earth to be represented by unity; then, from the common tables of logarithms, we easily deduce the following densities at greater heights:

Height.	Density.
1 mile.....	1.
2	0.7943
3	0.6309
4	0.5011
5	0.3981
6	0.3163
7	0.2511
8	0.1995
9	0.1585
10	0.1260

So that at 10 miles the density of the air is only $\frac{1}{8}$ th of its density at one mile above the surface of the earth.

Its height. These observations are sufficient to show that the height of the atmosphere above the surface of the earth must greatly exceed five miles; but how much, we have no data to enable us to determine.

Air possesses the property of refracting light; that is, of bending it from a right line, and making it move in a curve. The consequence of this property is, that the sun continues visible for some little time after he sets, and is seen also a short time before he rises. Nor are we deprived of all the benefits of his rays so long as any of them are capable of reaching the utmost limit of the atmosphere. This light, brought to the surface of the earth by the refracting power of the atmosphere, is called *twilight*; and mathematicians have endeavoured to determine the height of the atmosphere by observing how many degrees below the horizon the sun must sink before twilight ends. The result of this calculation is, that, at the height of 45 miles, the atmosphere has no sensible power of refracting light. Its rarity therefore at that height must be very great.

There is another way in which an estimate may be formed of the height of the atmosphere. That height must ultimately depend upon the degree of rarity which air is capable of bearing. The particles of air repel each other with forces varying inversely as the distances of the centres of these particles from each other. Now there is no great difficulty in rarefying air by means of a good air-pump, till it is capable of supporting a column of mercury only $\frac{1}{10}$ th of an inch in height. In such a case air is rarefied about 300 times, and the distance between the centres of its particles is increased seven times; consequently the force of repulsion between these particles is reduced to $\frac{1}{7}$ th of what it is when air is of its mean density. If we suppose that this is the utmost limit

to the rarefaction of air (a supposition not at all likely to be strictly true), we are entitled to infer that the atmosphere extends to the height of 40 miles, with properties yet unimpaired by extreme rarefaction.

If matter be infinitely divisible, the extent of the atmosphere must be equally infinite. But if air consists of ultimate atoms no longer divisible, then must the expansion of the medium composed of them cease at that distance where the force of gravity downwards upon a single particle is equal to the resisting force arising from the repulsive force of the particles. If the air be composed of indivisible atoms, our atmosphere may be conceived to be a medium of finite extent, and may be peculiar to our planet; but if we adopt the hypothesis of the infinite divisibility of matter, we must suppose the same medium to pervade all space, where it would not be in equilibrio, unless the sun, the moon, and all the planets, possess their respective shares of it condensed around them, in degrees depending on the force of their respective attractions.

It is obvious that the atmosphere of the moon (suppos- Has a ing it to have any) could not be perceived by us; for, limit. since the density of an atmosphere of infinite divisibility at her surface would depend upon the force of her gravitation at that point, it would not be greater than that of our atmosphere when the earth's attraction is equal to that of the moon at her surface. Now this takes place at about 5000 miles from the earth's surface,—a height at which our atmosphere, supposing it to extend so far, would be quite insensible.

But since Jupiter is fully 309 times greater than the earth, the distance at which his action is equal to gravity must be as $\sqrt{309}$, or about 17.6 times the earth's radius; and since his diameter is nearly 11 times greater than that of the earth, $\frac{17.6}{11} = 1.6$ times his own radius will be

the distance from his centre at which an atmosphere equal to our own should occasion a refraction exceeding 1° . To the fourth satellite this distance would subtend an angle of about $3^\circ 37'$; so that an increase of density to $3\frac{1}{2}$ times our common atmosphere would be more than sufficient to render the fourth satellite visible to us when behind the centre of the planet, and consequently to make it appear on both sides at the same time. It is needless to say that this does not happen, and that the approach of the satellites, instead of being retarded by refraction, is regular till they appear in actual contact; showing that there is not that extent of atmosphere which Jupiter should attract to himself from an infinitely divisible medium filling space.

If the mass of the sun be considered as 330,000 times that of the earth, the distance at which his force is equal to gravitation will be $\sqrt{330,000}$, or about 575 times the earth's radius; and if his radius be 111.5 times that of the earth, then this distance will be $\frac{575}{111.5} = 5.15$ times

the sun's radius. But Dr Wollaston has shown, by the phenomena attending the passage of Venus very near the sun on the 23d May 1821, that the sun has no sensible atmosphere. For the apparent and calculated place of that planet were the same when the planet was only $53' 15''$ from the sun's centre. M. Vidal of Montpellier observed Venus on the 30th May 1805, when her distance from the centre of the sun was only $46'$ of space; and the apparent and calculated positions of that planet corresponded. These observations leave no doubt that the sun has no sensible atmosphere, and of course are inconsistent with the notion of the infinite divisibility of the matter of our atmosphere.

Atmo- sphere.

Atmo-
sphere.About 45
miles high.Air a mix-
ture of two
gases,oxygen
and azotic.

But if air consist of atoms incapable of further division, it is obvious that the height of the atmosphere has a limit, and that limit is the place where the gravitation of the atoms of air just balance the force of their repulsion. The exact situation of this limit we cannot assign; but it cannot far exceed the height of 45 miles above the earth's surface. Nor are the objections to this determination drawn from meteors of sufficient weight to overturn the force of the arguments just adduced. Dr Halley observed a meteor in the month of May 1719, whose altitude he computed to be between 69 and 73½ English miles, its diameter 2800 yards, and its velocity about 350 miles in a minute. The celebrated meteor which appeared on the 18th August 1783 was not less than 90 miles above the surface of the earth. Its diameter must have been at least equal to that of Dr Halley's meteor, and its velocity certainly not less than 1000 miles in a minute. We know too little about the nature of these meteors to connect them with the earth's atmosphere. Indeed their velocity would lead to the conclusion that they were revolving round the earth like satellites. The light which they emitted, or the state of combustion which they exhibited, we cannot explain. But the same difficulty occurs to account for the volcanoes which have been seen in the moon, though we are quite certain that her atmosphere is far too rare to support combustion.

The ancients thought that air constituted one of the four elements, from which, in their opinion, all things originated; and this doctrine continued prevalent till after the year 1774. It was during that year that Dr Priestley first discovered oxygen gas, and showed it to be a constituent of air. He determined several of its most remarkable properties, and called it *dephlogisticated air*, from a notion he entertained that it was air deprived of *phlogiston*.

When *azotic* gas, the other constituent of air, was discovered soon after, the difference between its properties and those of oxygen gas could not fail to strike the most careless observer. Bodies burn more rapidly, with much greater splendour, and with the evolution of much greater heat, in oxygen gas than they do in common air; while in azotic gas they cannot be made to burn at all. Animals breathe oxygen gas without inconvenience, and they live much longer when confined in a given bulk of it, than when in the same volume of common air; but in azotic gas animals cannot live at all. When plunged into it they die of suffocation, precisely as they would do if plunged under water. Dr Priestley considered *oxygen* gas as the pure elementary principle of the ancients: common air was oxygen united to a certain quantity of *phlogiston*, while azotic gas was oxygen saturated with *phlogiston*.

Scheele discovered both oxygen and azotic gas, without any knowledge of what had been done in Britain; and he first drew the proper consequences from his experiments. Air, in his opinion, consists essentially of a mixture of two distinct elastic fluids, namely, oxygen and azote. He determined the properties of each, and made a set of experiments to ascertain the relative volumes of each contained in the atmosphere. The result of these experiments led him to the conclusion that air is a mixture of

27 volumes oxygen gas,
73 volumes azotic gas.

100.

Lavoisier drew the same conclusions as Scheele had done; and he assures us that he did so before he knew any thing of the researches and discoveries of the Swedish chemist; and, what is very remarkable, he deduced the same volumes of each gas, as constituents of the atmosphere, as Scheele had done. His experiments were made

in the same way as Scheele's, and no doubt the mistakes of both had the same origin.

It was in 1782 that Mr Cavendish, by a careful analysis of the air in the neighbourhood of London, repeated frequently, and continued for a whole year, determined that the volume of oxygen gas in atmospherical air is a good deal smaller than Scheele and Lavoisier had made it. He found the constituents of air to be—

79·18 volumes of azote,
20·82 volumes of oxygen.

100·00.

He found that these proportions never varied, though he analyzed air at different periods of the day, and during all the different seasons of the year. Hence it followed that the conclusions drawn by Dr Ingenhousz and others, that air differs in the proportion of oxygen gas which it contains in different parts of the earth, and that the salubrity of different places is connected with this difference, were erroneous.

These experiments of Mr Cavendish were published in the *Philosophical Transactions* for 1783; but they continued for many years unattended to. The determination of Scheele and Lavoisier was universally adopted; and the notion of Dr Ingenhousz, that the proportions between the oxygen and the azote vary in different places, was also adopted. At last, in 1802, Berthollet announced that he had frequently analyzed the air in Egypt, by absorbing its oxygen by means of a stick of phosphorus, and that he had always found it a compound of

79 volumes azote,
21 volumes oxygen.

100.

Davy about the same time announced that he had tried air from the coast of Africa, from Cornwall, and from the neighbourhood of Bristol, and had uniformly found it composed of 79 volumes of azotic gas and 21 volumes of oxygen gas. It was soon after analyzed in Edinburgh, in North America, and in France, with the very same results. Gay-Lussac and Humboldt made a set of careful experiments to determine the exact proportions of the two constituents, and confirmed the ratio of 21 volumes of oxygen gas and 79 volumes of azotic gas. This ratio has been generally adopted by chemists.

But there is a circumstance which cannot avoid striking an attentive observer; namely, the very near approach of these numbers to 80 volumes azotic and 20 volumes oxygen gas, or four volumes azotic and one volume oxygen gas. It has been deduced from a great variety of unexceptionable experiments, that a volume of azotic gas is equivalent to an atom, while half a volume of oxygen gas is equivalent to an atom. Hence four volumes azotic and one volume oxygen gases are equivalent to four atoms azote and two atoms oxygen, or to two atoms azote and one atom oxygen. If, therefore, we were to admit that air consists of 80 volumes azotic and 20 volumes of oxygen gases, it would follow that it is a compound of two atoms azote and one atom oxygen. There is no evidence, indeed, that in air the oxygen and azotic gases are chemically combined; the phenomena of air rather lead to the conclusion that the two elastic fluids are merely mixed. And the hypothesis of Dalton, that the particles of elastic fluids only repel particles of their own kind, but that two elastic fluids are not mutually elastic to each other, will enable us to account for their remaining intimately mixed, though not chemically united.

It may seem immaterial, then, whether air be a mixture of azotic and oxygen gases in the proportion of two atoms of the former to one atom of the latter, or in the pro-

Atmo-
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portion (as chemists at present think) of 1.975 atom azote and 1.05 atom oxygen; or, as fractions of atoms can hardly be admitted, of 79 atoms of azote and 42 atoms of oxygen. But certainly the constitution of air must appear much simpler, and therefore much more agreeable to contemplate, when viewed as consisting of the simple ratio of two to one, than in the much more complex ratio of 79 to 42. The writer of this article was induced in consequence to make a set of experiments with all possible attention to accuracy, in order to deduce the volume of oxygen gas which it contains. The air was collected in a grass field at some distance from houses and trees; and this spot was selected as likely to furnish air containing as great a proportion of oxygen as it ever contains, because grass and vegetables in general are supposed to make up the waste of oxygen which the air sustains by the processes of combustion and respiration,¹ and because the quantity of carbonic acid which it was likely to contain would be too small to make any sensible alteration in the experiments.

Ten measured volumes of this air were placed successively in a small glass jar, over mercury, together with a stick of phosphorus. After the oxygen gas had been removed by the phosphorus, the air was washed, and then measured. The following table exhibits the result of these ten trials. 100 volumes of air consist of

	Volumes of Azotic Gas.	Volumes of Oxygen Gas.
1.....	80.927.....	19.073
2.....	79.246.....	20.754
3.....	80.504.....	19.496
4.....	79.532.....	20.468
5.....	79.851.....	20.149
6.....	79.652.....	20.348
7.....	79.374.....	20.626
8.....	80.770.....	19.230
9.....	79.843.....	20.157
10.....	80.028.....	19.972

Mean,.....79.9735,.....20.0265

The mean of these ten trials gives us air, a mixture of 79.9735 volumes of azotic and 20.0265 volumes of oxygen gas. Now, this approaches as near 80 volumes of azotic and 20 volumes of oxygen gas as the mode of experimenting permitted, for the measure employed to determine the volume of the gases was about half an inch in diameter.

It was found, also, that when 100 volumes of air were mixed with 42 volumes of hydrogen gas, and an electric spark passed through the mixture, the diminution of bulk by the explosion was precisely 60 volumes; and this in three successive experiments. Now, this diminution is owing to the oxygen of the air uniting with the hydrogen gas and forming water, and water is a compound of two volumes hydrogen and one volume oxygen gas. The third part of the diminution, therefore, gives us the quantity of oxygen gas consumed. Now, the third of 60 is 20, which constitutes therefore the volumes of oxygen gas in 100 volumes of air.

If we employ less than 42 volumes of hydrogen gas, the whole oxygen of the air is not consumed. Thus, when we employ a mixture of 100 volumes of air and 40 volumes of hydrogen gas, the diminution of volume after combustion is only 57 volumes, which would indicate 19 volumes of oxygen instead of 20 in the air; so that one

volume of oxygen in this case has escaped combustion. When we mix more hydrogen than 42 volumes with 100 volumes of common air, the diminution of volume is somewhat greater than 60, and it goes on increasing slowly till the volume of hydrogen gas is equal to that of the air. 100 volumes of air being mixed with 100 volumes of hydrogen gas, and fired, the diminution amounted to 64 volumes. This would raise the amount of the oxygen in 100 volumes of air to $21\frac{1}{2}$ volumes.

It is obvious from these experiments that absolute certainty cannot be obtained by firing mixtures of air and hydrogen gas. The reason, doubtless, is, that when the surplus of hydrogen is considerable, a little of it unites with the azotic gas of the air, and forms ammonia, which, being absorbed by the water over which the explosion is made, occasions a greater diminution of bulk than would have proceeded from the simple union of all the oxygen of the air with hydrogen gas.

Knowing the composition of air to be 80 volumes azotic Specific and 20 volumes oxygen gas, and knowing the atomic gravity of weight of these bodies to be azote 1.75 and oxygen 1, these two we can easily deduce the specific gravity of azotic and oxygen gases, reckoning that of air unity, in the following manner:—

100 parts of air by weight must be a compound of

oxygen $22.22=a$,

azote $77.77=b$.

Let x =specific gravity of oxygen gas,

y =specific gravity of azotic gas,

$$\frac{x+4y}{5} = 1 \text{ and } x = 5 - 4y$$

$$x : 4y :: a : b \text{ and } x = \frac{4ay}{b}.$$

Hence $5 - 4y = \frac{4ay}{b}$, from which we deduce

$$y = \frac{5b}{4a+4b} = \frac{5 \times 77.77}{4 \times 22.22 + 4 \times 77.77} = 0.9722$$

$$\text{and } x = 5 - 4y = 5 - 3.8888 = 1.1111.$$

Thus, the specific gravity of these two gases is as follows:—

oxygen gas.....1.1111,

azotic gas.....0.9722.

That the specific gravity of these two gases hitherto determined by the most careful experimenters is inaccurate, is obvious from this, that when we calculate the specific gravity of air from them, it never comes out unity, but usually higher than unity.

Besides oxygen and azotic gases, air contains likewise a little carbonic acid gas. Who first made that remark we do not know; but it could not avoid being inferred as soon as the cause of the difference between caustic and mild alkali came to be known. Chemists at first stated the volume of carbonic acid gas in the atmosphere at 1 per cent., but this determination was not founded on any accurate experiments. Mr Dalton found the quantity much smaller than had been stated by preceding experimenters. He observed, that if a glass vessel, filled with 102,400 grains of rain water, be emptied in the open air, and 125 grains of lime water poured in, and the mouth then closed, by sufficient time and agitation the whole of the lime water is just saturated with the carbonic acid which it finds in the inclosed volume of air; but 125 mea-

¹ It is easy to show, that whether the oxygen thus withdrawn from the air be supplied or not, no alteration in the proportions of the constituents amounting to one millionth part can possibly have taken place. It would therefore be quite insensible as far as our means of estimating it can go.

Atmo-
sphere.

tures of lime water require 70 measures of carbonic acid gas to saturate them. Hence it follows that 10,000 volumes of air contain 6.8 volumes of carbonic acid.¹ The- nard ascertained by means of barytes water that 10,000 volumes of air which he examined contained 3.91 volumes of carbonic acid.² This is little more than half the quan- tity found by Mr Dalton. But by far the most complete set of experiments on the volume of carbonic acid gas in the atmosphere was made by M. Saussure. He abstract- ed the carbonic acid from given volumes of air by means of barytes water. The carbonic acid was estimated by dissolving the precipitated carbonate of barytes in muria- tic acid, and throwing down the barytes in the state of sulphate from the solution. The sulphate of barytes, ig- nited and weighed, easily furnished the weight of carbo- nic acid; and this weight, together with the known speci- fic gravity of carbonic acid gas, furnished the data for de- termining its volume. The experiments were continued for two years. Sometimes (indeed most commonly) the air examined was collected at Chambeisy, a meadow about three fourths of a league from Geneva, elevated about 52½ feet above the lake, and distant from it 820 feet. Its elevation above the level of the sea is 1272 feet. It is dry, open, and consists of a clay soil, a little inclined. The mean quantity of carbonic acid gas found in 10,000 volumes of air deduced from 104 observations made dur- ing both day and night, and at all seasons, was 4.15 vo- lumes. The greatest quantity was 5.74 volumes, and the smallest 3.13 volumes. The quantity of this gas is affected by rainy weather; for when the soil is soaked with water, it has the property of imbibing this gas. Hence in rainy seasons the quantity of carbonic acid gas in the atmosphere is usually rather less than in dry sea- sons. On the contrary, it would seem, from the observa- tions of Saussure, that a continued frost has a tendency to augment the quantity of carbonic acid in the atmosphere, doubtless because the frozen and dry soil does not pos- sess the property of absorbing it.

Air taken from the surface of the lake of Geneva, at an elevation of four feet, was found in general to contain less carbonic acid than the air of Chambeisy; but the same kind of variation, depending on the season of the year, was observable in both. Air from the streets of Geneva, on the contrary, was found rather more loaded with car- bonic acid than the air above Chambeisy; but the differ- ence was not great. The volume of carbonic acid in air from the tops of mountains was found to be rather greater than that of carbonic acid in air from the low country; and this difference is more remarkable in rainy than in dry weather.

Wind has rather a tendency to augment the quantity of carbonic acid in the air in low situations, doubtless by mixing together the air on the mountains and in the val- leys; but the difference is so small that it only becomes perceptible by a long series of observations.

In general, the air over plains contains a greater pro- portion of carbonic acid during the night than during the day; but this difference is not nearly so great in winter as in summer. Indeed during that season of the year the quantity is often as great or even greater during the day than during the night.³

The reason why the quantity of carbonic acid gas in the atmosphere is greater in the superior strata than at the surface of the earth, is, probably, that vegetables have the property of absorbing it and applying it to the pur- poses of vegetation. Hence, doubtless, the reason why it does not increase, notwithstanding the prodigious quan-

tity of it constantly thrown into the atmosphere by the breathing of animals and the combustion of fuel.

If we admit the mean volume of carbonic acid gas in air to be 0.000415, then the true component parts of 100 volumes of air will be

Azotic gas.....	79.9668
Oxygen gas.....	19.9917
Carbonic acid gas.....	0.0415

100.

This, doubtless, will somewhat modify the specific gra- vity of oxygen and azotic gases; but the alteration is too insignificant to claim any attention.

Besides these three constituents, there is a fourth, name- ly, the vapour of water, from which air is never altogether free, and the proportion of which, owing to causes which cannot at present be fully explained, is continually after- ing. The consequence of this is, that if we weigh air in its natural state ever so often, we shall hardly ever find its weight in any two consecutive experiments altogether the same. It is sufficiently known that water evaporates spontaneously at all temperatures, and mixes with air in the state of an invisible elastic fluid known by the name of *vapour* or of *steam* when its elasticity is so great as to balance that of the atmosphere. The elasticity of vapour varies with the temperature. At 32° it is capable of sup- porting a column of mercury 0.2 inch high. At 80° it supports a column of 1 inch, at 163° of about 10 inches, at 180° of about 15 inches, and at 212° of about 30 inches. Now, the quantity of it which can exist in the atmosphere at the same time is proportional to this elasticity.

Mr Dalton has shown, that if p = pressure of the atmo- sphere in inches of mercury, f = elasticity of vapour con- tained in the atmosphere, x = volume of dry air in 100 volumes of the given atmospherical air; then

$$\frac{px}{p-f} = 100; \text{ consequently } x = \frac{100}{\frac{p}{p-f}}.$$

Let air be saturated with moisture at 32°. In that case we have

$$\frac{px}{p-f} = \frac{30}{29.8} = 1.00671$$

$$x = \frac{100}{1.00671} = 99.333;$$

so that the volume of vapour (supposing its specific gra- vity 0.625) in 100 volumes of such air will amount to 0.666, which is just $\frac{1}{150}$ th part of the volume of the air.

At the temperature of 60° $f = 0.52$, we have therefore

$$\frac{px}{p-f} = \frac{30x}{29.48} = 100, \text{ and } x = 98.267; \text{ so that the vo- lue of vapour capable of existing in the atmosphere at } 60^\circ \text{ is } \frac{17.33}{100.000} \text{ of the atmosphere.}$$

The highest temperature that the writer of this article has had an opportunity of witnessing in Great Britain was 93°. At that temperature $f = 1.5$

$$\frac{px}{p-f} = \frac{30x}{28.5} = 100, \text{ and } x = 95;$$

so that the volume of vapour capable of existing in the atmosphere at such a temperature is $\frac{5}{100}$ or $\frac{1}{20}$.

To determine the volume of vapour in the atmosphere

Atmo-
sphere.
Its quan-
tity.¹ Phil. Mag. (1st series), xxiii. 354.² Traité Elem. de Chim. i. 303.³ Ann. de Chim. et de Phys. xlv. 5.

Atmo- sphere. at any particular time, various instruments have been contrived, called *hygrometers*, some more and some less exact; but the simplest and most accurate method of all is that employed by Leroi, and afterwards by Mr Dalton. Take a glass tumbler, as thin as possible, and fill it with water somewhat colder than the temperature of the air at the time. Observe if vapour be condensed on the outside of the tumbler; if not, the water employed is not cold enough for our purpose. Its temperature must be lowered either by putting pieces of ice into it or by dissolving in it some carbonate of soda or sulphate of soda, retaining their water of crystallization, but in powder. If vapour condense on the outside of the tumbler, pour out the water into another glass and wipe the outside of the tumbler dry. When the temperature of the water has had time to be a little elevated, pour it into the tumbler again, and observe whether moisture condense on the outside of the glass. If it do, pour out the water, wipe the outside of the tumbler again, and repeat the process when the water has become a little warmer. This method of proceeding is to be persevered in till you find the temperature at which the moisture just ceases to be condensed on the glass. That temperature, by means of the following table, will enable you to determine the volume of vapour (of the specific gravity 0.625) existing in the atmosphere at the time that your observation is made. Atmo- sphere.

Temperature.	Force of Vapour in Inches of Mercury.	Temperature.	Force of Vapour in Inches of Mercury.	Temperature.	Force of Vapour in Inches of Mercury.	Temperature.	Force of Vapour in Inches of Mercury.
32°	0.2000	47°	0.3264	62°	0.5560	77°	0.9175
33	0.2066	48	0.3372	63	0.5749	78	0.9487
34	0.2134	49	0.3483	64	0.5944	79	0.9809
35	0.2204	50	0.3600	65	0.6146	80	1.0120
36	0.2277	51	0.3735	66	0.6355	81	1.04
37	0.2352	52	0.3875	67	0.6571	82	1.07
38	0.2429	53	0.4020	68	0.6794	83	1.10
39	0.2509	54	0.4171	69	0.7025	84	1.14
40	0.2600	55	0.4327	70	0.7260	85	1.17
41	0.2686	56	0.4489	71	0.7507	86	1.21
42	0.2775	57	0.4657	72	0.7762	87	1.24
43	0.2866	58	0.4832	73	0.8026	88	1.28
44	0.2961	59	0.5012	74	0.8299	89	1.32
45	0.3059	60	0.5200	75	0.8581	90	1.36
46	0.3160	61	0.5377	76	0.8873		

Suppose we find that the temperature of the water when moisture ceases to be condensed on the outside of the tumbler is 40°, we look into the above table, and opposite to 40° in it, we find 0.26 inch of mercury. This denotes the force of the vapour contained in the atmosphere at the time our experiment was made. Suppose the barometer to be standing at 30 inches, then the volume of vapour in the atmosphere is $\frac{0.26}{30.00}$, or nearly $\frac{1}{115}$ of the volume of the atmosphere.

The absolute quantity of vapour in the atmosphere is usually greatest in summer on account of the temperature being so much higher; but the moisture or dryness of the air does not depend so much upon the absolute quantity of vapour which it contains, as on its approach to saturation. Suppose the temperature of the air to be 60°, and that a tumbler filled with water of 60° condenses water on its outside. This would indicate a force of vapour equal to 0.52 inch of mercury. Now, as this is the force of vapour at 60°, it is clear that as much vapour exists in the air as is possible at that temperature. The air is saturated with moisture, evaporation cannot go on in it, and moisture will be deposited upon all bodies the least colder than the air itself. Such a state of things takes place pretty frequently in this country during winter, though rarely during summer. Hence the atmosphere is moister during winter than during summer, though the absolute quantity of vapour which it contains may be much less.

With respect to the quantity of vapour in the atmosphere we have still very few data. Mr Daniel, in his book on Meteorology, has given a table of the force of vapour in the atmosphere at London for three years. The

following table gives the mean force of vapour in Glasgow during every fortnight, from May 1823 to February 1824:

		Force of Vapour in Inches of Mercury.	Quantity of vapour in the air at Glasgow.
1823. May,	1st fortnight.....	0.2707	
	2d.....	0.3494	
June,	1st.....	0.3052	
	2d.....	0.2822	
July,	1st.....	0.3526	
	2d.....	0.3819	
August,	1st.....	0.4000	
	2d.....	0.3546	
September,	1st.....	0.3790	
	2d.....	0.3404	
October,	1st.....	0.3233	
	2d.....	0.3026	
November,	1st.....	0.2808	
	2d.....	0.3230	
December,	1st.....	0.2449	
	2d.....	0.2453	
1824. January,	1st.....	0.2481	
	2d.....	0.2578	
February,	1st.....	0.2468	
	2d.....	0.2170	

The mean force of vapour in the atmosphere in Glasgow is nearly 0.3 inch, which indicates the quantity of vapour capable of existing in the atmosphere at 45°. Now the mean temperature of Glasgow is 47°.75. It is obvious from this that the atmosphere in that part of Scotland is moist.

It would be very interesting if we knew the force of

Atmo-
sphere.

vapour at all the different seasons in the torrid zone. The regularity of the weather in these climates, and the little alteration in height of the barometer, would make a set of such observations particularly valuable. They would probably throw more light on the theory of rain than has yet been done. The only set of observations which we have seen on the quantity of vapour in countries approaching the torrid zone, are the following by Dr Heinecker, in which he gives the maximum and minimum dew points at Funchal in Madeira (lat. $32\frac{1}{2}$ N.), during the year 1828, which in that part of the world was remarkably dry.

	Maximum.	Minimum.	Rain in Inches.
January.....	65°	50°	4.08
February.....	56	50	1.64
March.....	65	48	1.68
April.....	63	45	3.35
May.....	69	51	2.14
June.....	70	54	0.21
July.....	72	61	0.10
August.....	73	63	0
September....	75	69	1.39
October.....	74	56	0
November....	72.5	54	2.56
December....	67	50	0.52

17.67¹

These observations are not sufficient to give us an accurate notion of the state of the atmosphere at Funchal. The highest dew point is 75°, indicating a force of vapour amounting to 0.8581 inch, so that the vapour at that time in the atmosphere was nearly $\frac{1}{35}$ th of its volume. The lowest dew point is 45°, indicating a force of vapour amounting to 0.3059 inch, so that the vapour at that time in the atmosphere was nearly $\frac{1}{100}$ th of its volume. The mean dew point deduced from the maxima and minima is 61°, indicating a force of vapour of 0.5377 inch, or a quantity of vapour amounting to nearly $\frac{1}{35}$ th of the volume of the atmosphere. The mean temperature of Madeira is 66°.3. Now since the mean dew point is 61°, it is obvious that the atmosphere over Madeira is much drier than at Glasgow, though the absolute quantity of vapour which it contains is much greater.

Why the
different
gases in air
remain
mixed.

Thus the atmosphere is a mixture of at least four different elastic fluids, namely, azotic gas, oxygen gas, carbonic acid gas, and the vapour of water. Doubtless all other gaseous bodies and many vapours exist in it also, but in too small quantities to be discovered by the most delicate tests that we have it in our power to apply. These different elastic fluids are mixed equably together; and though there be a considerable difference in their specific gravities, that difference has no tendency to cause them to separate. The reason of this equable mixture was first pointed out by Dalton. It depends upon a principle not yet generally recognised, but of the existence of which recent observations leave little doubt. This principle is, that the particles of elastic fluids are not mutually elastic to each other. The particles of oxygen repel the particles of oxygen, the particles of azotic gas repel those of azotic gas; but a particle of oxygen does not repel a particle of azotic gas. Hence, when a gas issues from an orifice into a space filled by another gas, it rushes precisely as if it were flowing into a vacuum. But the full development of this important principle belongs to the article PNEUMATICS.

Salubrity
of the at-
mosphere.

A great deal has been written about the salubrity of the atmosphere in different countries. It has been supposed, and

is still believed, that the average length of life in different places depends chiefly upon the state of the atmosphere. It has been generally admitted that the atmosphere is frequently a vehicle by which diseases are communicated; and the prevalence of certain epidemic diseases, as the plague and the yellow fever, in particular places, at particular seasons, has been accounted for in this way. But no satisfactory evidence has ever been adduced to satisfy us of the accuracy of these opinions. The constituents of the atmosphere, azotic and oxygen gases, never undergo any sensible change in their proportions. Carbonic acid varies somewhat, but its proportion is always so small that it cannot be considered as a source of disease. The proportion of aqueous vapour is much more variable, and there can be no doubt that it may have an effect upon individuals predisposed to certain diseases. Consumptive patients suffer much more when they breathe a very moist than when they breathe a dry atmosphere. There are few places in the habitable globe, if there be any, where the atmosphere is constantly saturated with moisture; and it cannot prove very injurious, even to consumptive patients, except when in this state. Besides, that a very dry atmosphere is not the best adapted for the continuance of health, is obvious from the sufferings to which those who inhabit the west coast of Africa are liable during the prevalence of the sirocco, a wind so excessively dry that even the wood of the floors shrinks in consequence of its action.

Nothing has been more completely ascertained than that marshy countries are subject to intermittent fevers, and that the malignancy of these intermittent fevers increases with the heat of the climate. These diseases disappear when the marshes are drained, and therefore are connected with moisture; but that they are not owing to mere moisture, is obvious from this, that they do not appear at the sea-shore or on the banks of rivers, though the moisture be as great as in marshy countries. It is the general opinion that these diseases owe their origin to certain vapours which are given out during the putrefaction of vegetable substances; but of the nature of these *miasmata* nothing is known. In the West Indies marshes are most fatal to the inhabitants just when they are almost (but not quite) dried up by the heat of the weather. It is then that the exhalations are most abundant and most deadly. It is known that smallpox, &c. may be communicated by the mixture of a particular matter with the blood. It is possible, though not very probable, that this matter may at times exist in the atmosphere in the state of vapour, or in combination with one or other of the constituents of air, most probably the aqueous vapour, and the disease may be communicated by breathing such air. It is a conceivable thing that the matter, which, like a ferment, is capable of inducing certain diseases when it enters into the blood, may exist occasionally united to the aqueous vapour in the atmosphere.

It has been ascertained, by experiments that seem conclusive, that these noxious states of the atmosphere, however they originate, may be destroyed, and the air rendered healthy, by mixing it with chlorine. This is most easily accomplished by introducing into the chamber to be so purified a quantity of chloride of lime in an open dish and pouring on it sulphuric acid. The chlorine is disengaged and speedily fills the apartment. Then the mixture is withdrawn and the room ventilated. See CLIMATE, METEOROLOGY, PNEUMATICS. (L.)

ATOM, in *Philosophy*, a particle of matter, so minute as to admit of no division. Atoms are the *minima nature*,

Atmo-
sphere
||
Atom.¹ Brewster's *Journal* (new series), i. 34.

Atomical Philosophy and are conceived to be the first principles or component parts of all physical magnitude.

ATOMICAL PHILOSOPHY, or the doctrine of atoms, a system which, from the hypothesis that atoms are endued with gravity and motion, accounted for the origin and formation of all things. This philosophy was first broached by Democritus, and afterwards cultivated and improved by Epicurus, whence it is denominated the *Epicurean Philosophy*.

ATOMIC THEORY. See CHEMISTRY.

ATONEMENT. See EXPIATION.

ATOOL, one of the larger Sandwich Islands, in the South Pacific Ocean. Towards the north-east and north-west the country is rugged and broken, but to the southward it is more level. The hills rise from the sea with a gentle acclivity, and at a little distance back are covered with wood. The produce of this island is the same with that of the rest of the cluster; but its inhabitants greatly excel their neighbours in the management of their plantations. It is nearly 30 miles in length, and contains about 54,000 inhabitants. Long. 200. 20. E. Lat. 21. 57. N.

ATREBATII, a people of Britain, who inhabited part of Berkshire and Oxfordshire, next to the Bibroci. This was one of those Belgic colonies which came out of Gaul into Britain, and there retained their ancient name. They are mentioned by Cæsar among the nations which composed the Belgic confederacy against him; and the quota of troops which they engaged to furnish on the occasion to which he refers was 15,000. Comius of Arras was a king or chieftain among the Atrebatii of Gaul in Cæsar's time; and he seems to have possessed some influence over the Atrebatii of Britain, for he was sent by Cæsar to persuade them to submission. This circumstance renders it probable that this colony of the Atrebatii had not been settled in Britain very long before that time. The Atrebatii were amongst the British tribes which submitted to Cæsar; nor do we hear of any remarkable resistance they made against the Romans at their next invasion under Claudius. It is indeed probable that, before the time of this second invasion, they had been subdued by some of the neighbouring states; perhaps by the powerful nation of the Cativellauni; which may also be the reason why they are so little mentioned in history. Calliva Atrebatum, mentioned in the seventh, twelfth, thirteenth, and fourteenth Itinera of Antoninus, and called by Ptolemy *Calcula*, seems to have been the capital of the Atrebatii. But our antiquaries differ respecting the situation of this ancient city; some of them placing it at Wallingford, and others at Ilchester.

ATREUS, in *Fabulous History*, the son of Pelops and Hippodamia, and the father of Agamemnon and Menelaus, is supposed to have been king of Mycenæ and Argos about 1228 years before the Christian era. He drove his brother Thyestes from court for having criminal intercourse with Ærope his wife; but, understanding that two children were the fruit of this connection, he recalled his brother, and made him eat them; at which horrid action the sun, it is said, withdrew his light.

ATRI, or **ATRIA**, a town of Naples, in Abruzzo Citra, with the title of a duchy. It is seated on a craggy mountain, 28 miles north-east of Aquila. Long. 13. 58. E. Lat. 42. 32. N.

ATRIENSES, in *Antiquity*, a kind of servants or officers in the great families of Rome, who had the care and inspection of the atria and the things lodged therein.

ATRIUM, in *Ecclesiastical Antiquity*, denotes an open place or court before a church, making part of what was called the *narthex* or *ante-temple*. The atrium in the ancient churches was a large area or square plat of ground, surrounded with a portico or cloister, situated between

the porch or vestibule of the church and the body of the church. Some have erroneously confounded the atrium with the porch or vestibule, from which it was distinct; others with the narthex, of which it was only a part. The atrium was the mansion of those who were not suffered to enter farther into the church; and more particularly, it was the place where the first class of penitents stood to beg the prayers of the faithful as they went into the church.

ATROPHY, in *Medicine*, a disease in which the body, or some of its parts, does not receive the necessary nutriment from the blood, but wastes and decays incessantly.

ATROPOS, in *Fabulous History*, the name of the third of the Parcæ or Fates, whose business it was to cut the thread of life.

ATTACHMENT, in *English Law*, implies the taking or apprehending of a person by virtue of a writ or precept. It is distinguished from an *arrest* by proceeding out of a higher court by precept or writ; whereas the latter proceeds out of an inferior court by precept only. An arrest lies only against the body of a man; whereas an attachment lies often against the goods only, and sometimes against the body and goods. An attachment by writ differs from *distress* in not extending to lands; and a distress touches not the body, as an attachment does.

ATTACOTTI, an ancient people of Britain, mentioned by Ammianus Marcellinus and St Jerome, as well as in the *Notitia Imperii*. They are represented as allies and confederates of the Scots and Picts, and therefore probably their neighbours; though their precise situation has not been determined by antiquaries.

ATTAINDER, in *Law*, is that species of infamy which is incurred by one who has been capitally convicted of a felony, treason, or other great crime. In that case the law sets a note of infamy upon him, puts him out of its protection, and takes no further care of him than barely to see him executed. He is then called *attaint*, *attinctus*, *stained* or *blackened*. He is no longer of any credit or reputation; he cannot be a witness in any court, neither is he capable of performing the functions of another man; for, by an anticipation of his punishment, he is already dead in law. This is after judgment; but there is a great difference between a man *convicted* and *attainted*, although they are frequently through inaccuracy confounded together. After conviction only a man is liable to none of these disabilities; for there is still in the contemplation of law a possibility of his innocence. Something may be offered in arrest of judgment; the indictment may be erroneous, which will render his guilt uncertain, and thereupon the present conviction may be quashed: he may obtain a pardon, or be allowed the benefit of clergy; each of which supposes some latent sparks of merit, which plead in extenuation of his fault. But when judgment is once pronounced, both law and fact concur in holding him completely guilty; and there is not the remotest possibility left of any thing effectual being said in his favour. Upon judgment of death, therefore, and not before, the attainder of a criminal commences; or upon such circumstances as are equivalent to judgment of death, as judgment of outlawry on a capital charge, pronounced for absconding or fleeing from justice, which tacitly confesses the guilt; and therefore, upon judgment either of outlawry or of death, for treason or felony, a man is said to be attainted.

ATTENTION, a due application of the ear or of the mind to any thing said or done, in order to acquire a knowledge thereof. The word is compounded of *ad*, to, and the verbal substantive derived from *tendo*, I stretch.

Attention, in respect of hearing, is the stretching or straining of the *membrana tympani*, so as to make it more susceptible of sounds, and better prepared to catch even a feeble agitation of the air; or it is the adjusting of the

Atomical
Philosophy
||
Atrium.

Atrophy
||
Attention.

Attenuation || Atterbury. tension of that membrane to the degree of loudness or lowness of the sound to which we are attentive.

According to the degree of attention, objects make a stronger or weaker impression. Attention is requisite even to the simple act of seeing: the eye can take in a considerable field at one look, but no object in the field is seen distinctly except that singly which fixes the attention: in a profound reverie, which totally occupies the attention, we scarcely see what is directly before us. In a train of perceptions, no particular object makes such a figure as it would do singly and apart; for when the attention is divided among many objects, no particular object is entitled to a large share. Hence the stillness of night contributes to terror, there being nothing to divert the attention.

Attention is classed by Mr Dugald Stewart as a distinct faculty of the mind; an arrangement from which some other philosophers have dissented. But his admirable illustrations of the effects or results of attention are not at all dependent on the opinion which may be formed on this question. (See *Elements of the Philosophy of the Human Mind*, ch. ii.)

ATTENUATION, the act of making any fluid thinner and less consistent than it was before, or of enlarging bodies in superficial extent. The word is compounded of *ad*, to, and *tenuis*, thin.

ATTERBURY, DR FRANCIS, son of Dr Lewis Atterbury, was born at Milton in Buckinghamshire, in 1662; educated at Westminster; and thereafter elected to Christ Church in Oxford, where he soon distinguished himself by his fine genius and taste for polite literature. In 1687 he was made M. A., when he exerted himself in the controversy with the papists; vindicated Luther in the strongest manner; and showed an uncommon fund of learning, enlivened with great vivacity. In 1690 he married Miss Osborn, a distant relation of the duke of Leeds, and a lady of great beauty, but of small fortune.

In February 1690 and 1691 we find him resolved to "bestir himself in his office in the house," that of censor probably; an officer peculiar to Christ Church, who presides over the classical exercises. At the same time he held the catechetical lecture founded by Dr Busby.

It must have been about this period that he took orders, and entered upon another scene and another sort of conversation; for in 1691 he was elected lecturer of St Bride's Church in London, and preacher at Bridewell Chapel. An academic life, indeed, must have been irksome and insipid to a person of his active and aspiring temper. It was hardly possible that a clergyman of his fine genius, improved by study, and with a spirit to exert his talents, should remain long unnoticed; and accordingly we find that he was soon appointed chaplain to King William and Queen Mary.

The share which he took in the controversy with Bentley, about the genuineness of Phalaris's epistles, is now very clearly ascertained. In one of the letters to his noble pupil, dated Chelsea 1698, he says, the matter had cost him some time and trouble. "In laying the design of the book, in writing above half of it, in reviewing a good part of the rest, in transcribing the whole, and attending the press," he adds, "half a year of my life went away."

In 1700 a still larger field of activity opened, in which Atterbury was engaged four years with Dr Wake (afterwards archbishop of Canterbury) and others concerning the rights, powers, and privileges of convocations; an investigation in which, however the truth of the question may be supposed to lie, he displayed so much learning and ingenuity, as well as zeal for the interests of his order, that the lower house of convocation returned him their thanks, and the university of Oxford complimented him

with the degree of D. D. On the 29th January 1700 he was installed archdeacon of Totness, being promoted to that dignity by Sir Jonathan Trelawney, then bishop of Exeter. The same year he was engaged, with some other learned divines, in revising an intended edition of the Greek Testament, with Greek scholia, collected chiefly from the fathers by Mr Archdeacon Gregory. At this period he was very popular as preacher at the Rolls Chapel; an office which had been conferred on him by Sir John Trevor, a great discerner of abilities, in 1698, when he resigned Bridewell, which he had obtained in 1693. Upon the accession of Queen Anne in 1702, Dr Atterbury was appointed one of her majesty's chaplains in ordinary; and in October 1704 he was advanced to the deanery of Carlisle. About two years after this he was engaged in a dispute with Mr Hoadly concerning the advantages of virtue with regard to the present life, occasioned by his sermon preached 30th August 1706, at the funeral of Mr Thomas Bennet, a bookseller. In 1707 Sir Jonathan Trelawney, then bishop of Exeter, appointed him one of the canons residentiaries of that church. In 1709 he was engaged in a fresh dispute with Mr Hoadly concerning the doctrine of passive obedience, occasioned by his Latin sermon, entitled *Concio ad Clerum Londinensem, habita in Ecclesia S. Elphegi*. In 1710 came on the famous trial of Dr Sacheverell, whose remarkable speech on that occasion was generally supposed to have been drawn up by our author, in conjunction with Dr Smalridge and Dr Freind. The same year Dr Atterbury was unanimously chosen prolocutor of the lower house of convocation, and had the chief management of affairs in that house. On the 11th May 1711 he was appointed by the convocation one of the committee for comparing Mr Whiston's doctrines with those of the church of England; and in June following he had the chief hand in drawing up *A Representation of the Present State of Religion*. In 1712 Dr Atterbury was made dean of Christ Church, notwithstanding the strong interest and warm applications of several great men in behalf of his competitor Dr Smalridge. The next year saw him at the summit of his preferment, as well as of his reputation; for, in the beginning of June 1713, the queen, on the recommendation of Lord Chancellor Harcourt, advanced him to the bishopric of Rochester, with the deanery of Westminster in commendam. He was confirmed on the 4th July, and consecrated at Lambeth the next day.

In the beginning of the succeeding reign his tide of prosperity began to turn; and he received a sensible mortification presently after the coronation of King George I., when, upon his offering to present to his majesty, with a view, no doubt, of standing better in his favour, the chair of state or royal canopy, his own perquisite as dean of Westminster, the tender was rejected, not without some evident marks of dislike to his person.

During the rebellion in Scotland, and after the Pretender's declaration had been widely distributed, the archbishop of Canterbury, and the bishops in or near London, drew up and published a *Declaration of their abhorrence of the present Rebellion, and an Exhortation to the Clergy and People to be zealous in the discharge of their Duties to His Majesty King George*; but the bishop of Rochester refused to sign it, and engaged Bishop Smalridge to join in the refusal, on account of some reflections it contained against the high church party. In fact he appeared generally among the protestors against the measures of the king's ministers, and for the most part drew up the reasons of the protests with his own hand.

In 1716 we find him advising Dean Swift in the management of a refractory chapter. On the 26th April 1722 he sustained a severe trial in the loss of his lady,

Atterbury, by whom he had four children. In this memorable year, also, on a suspicion of his being concerned in a plot in favour of the Pretender, he was apprehended (24th August), and committed prisoner to the Tower. This commitment of a bishop upon suspicion of high treason, as it was a thing rarely practised since the Reformation, so it occasioned various speculations, which amused the nation at that time; and men, as usual, judged of things by the standard of their own affections and prejudices.

On the 23d March 1723 a bill was brought into the house of commons for inflicting certain pains and penalties on Francis, Lord Bishop of Rochester, a copy of which was sent to him, with notice that he had liberty of counsel and solicitors for making his defence. Under these circumstances the bishop applied by petition to the house of lords for their direction and advice as to his conduct in this conjuncture; and on the 4th April he acquainted the speaker of the house of commons, by letter, that he was determined to give that house no trouble in relation to the bill depending therein, but should be ready to make his defence against it when it should be argued in another house, of which he had the honour to be a member. On the 9th the bill passed the house of commons, and was the same day sent up to the house of lords for their concurrence.

May the 6th being the day appointed by the lords for the first reading of the bill, Bishop Atterbury was brought to Westminster to make his defence. The proceedings continued above a week; and, on May the 11th, he was permitted to plead for himself. This he did in a very eloquent speech, which he feelingly opens by complaining of the uncommon severity he had experienced in the tower, and which had been carried to so great a length that not even his son-in-law Mr Morice was permitted to speak to him in any other way than by standing in an open area, whilst the bishop looked out of a two-pair-of-stairs window. On the 13th he was carried for the last time from the tower in order to hear the reply of the king's counsel to his defence. On the 15th the bill was read a third time, and, after a very long and warm debate, passed on the 16th by a majority of 83 to 43. On the 27th the king came to the house and confirmed it by his royal assent. On the 18th June 1723 this eminent prelate, having the day before taken leave of his friends, who, from the time of the passing of the bill against him till the day of his departure, had free access to him in the tower, embarked on board the Aldborough man-of-war, and landed the Friday following at Calais. When he went on shore, being informed that Lord Bolingbroke (who, after the rising of the parliament, had received the king's pardon), was arrived at the same place on his return to England, he said, with an air of pleasantry, "Then I am exchanged." And it was, in the opinion of Mr Pope expressed on the same occasion, a sign that the nation was afraid of being overrun with too much politeness, when it could not regain one great man but at the expense of another. The severity of the bishop's treatment did not cease with his banishment; the same vindictive spirit pursued him even in foreign climes; and no British subject was permitted to visit him without the king's sign manual, which Mr Morice was always obliged to solicit, not only for himself, but for every one of his family whom he carried abroad with him, for which the fees of office were very high.

When Bishop Atterbury first entered upon his banishment, Brussels was the place destined for his residence; but, by the arts and instigation of the British ministers, he was compelled to leave that city, and retire to Paris.

There, being solicited by the friends of the Pretender to enter into their negotiations, he changed his abode for Montpellier in 1728; and after residing in the latter place about two years, returned to Paris, where he died on the 15th February 1732. The affliction which he had sustained by the death of his daughter in 1729 was thought to have hastened his own dissolution.

How far the bishop may have been attached by inclination to the cause of the Stuart family, to which he might have been led by early prejudices of education and the divided opinion of the times, it is not necessary here to inquire; but that he should have been weak enough to engage in a plot so inconsistent with his station, and so clumsily devised, to say nothing of his solemn asseveration of innocence, is utterly inconsistent with that cunning which his enemies ascribed to him. The duke of Wharton, it is well known, was violent against him, till convinced by his unanswerable reasoning.

His body was brought over to England, and interred in Westminster Abbey, in a vault which, in the year 1722, had been prepared by his directions. Some time before his death he published a vindication of himself, Bishop Smalridge, and Dr Aldrich, from a charge brought against them by Mr Oldmixon, of having altered and interpolated the copy of Lord Clarendon's *History of the Rebellion*. Atterbury's *Sermons* are extant in four volumes in octavo. Those contained in the first two were published by himself, and dedicated to his great patron Sir Jonathan Trelawney, bishop of Winchester; those contained in the last two were published after his death by Dr Thomas Moore, his lordship's chaplain. Four admirable *Visitation Charges* accompany his *Epistolary Correspondence*, published by Mr Nichols in 5 vols. 8vo.

As to Bishop Atterbury's character, however differently the moral and political part of it may have been represented by the opposite parties, it is universally agreed that he was a man of great learning and uncommon abilities, a fine writer, and a most excellent preacher. His learned friend Smalridge, in the speech he made when he presented him to the upper house of convocation, as prolocutor, styled him *Vir in nullo literarum genere hospes, in plerisque artibus et studiis diu et feliciter exercitatus, in maxime perfectis literarum disciplinis perfectissimus*. In his controversial writings he was sometimes severe to excess upon his adversary, and dealt rather too much in satire and invective; but this his panegyrist imputes more to the natural fervour of his wit than to any bitterness of temper or inherent malice of disposition. In his sermons, however, he is not only every way unexceptionable, but highly to be commended. The truth is, his talent as a preacher was so excellent and remarkable, that it may not improperly be said that he owed his preferment to the pulpit. "He has," says an author in the *Tatler*, "so particular a regard to his congregation, that he commits to his memory what he has to say to them; and has so soft and graceful a behaviour, that it must attract your attention. His person, it is to be confessed, is no small recommendation; but he is to be highly commended for not losing that advantage, and adding to propriety of speech (which might pass the criticism of Longinus) an action which would have been approved by Demosthenes. He never attempts your passions till he has convinced your reason. All the objections which you can form are laid open and dispersed before he uses the least vehemence in his sermon; but when he thinks he has your head, he very soon wins your heart, and never pretends to show the beauty of holiness till he has convinced you of the truth of it."

ATTICA,

Attica.
Boundaries and extent.

AN ancient kingdom of Greece, situated between the Strait of Euripus or Negropont on the north-east, and the Gulf of Saron or Ægina on the south-west, may be considered as forming a triangle, the base of which constituted the conterminous boundary with Bœotia, while the two other sides, washed by the sea, had their vertex at the promontory of Sunium or Cape Colonna. The prolongation of the south-western side northward till it reached the extremity of the base at the foot of Mount Cithæron served as the line of demarcation between the Athenian territory and that belonging to the small state of Megara. Hence Attica may be described generally as bounded on the north-east by the channel of Negropont, on the south-west by the Gulf of Ægina and part of Megara, and on the north-west by the territory which formed the ancient Bœotia; including, within these limits, an area or superficies of about 750 square miles.

Soil and climate.

The soil of Attica was not so unsuited to the purposes of agriculture as has commonly been supposed. It was, indeed, stony and uneven in many places; a considerable part consisted of bare rock, on which little or nothing could be grown; but even the less fertile portion produced barley and wheat, the latter, it is true, with difficulty; and the mildness of the climate allowed all the more valuable products of the earth to ripen the earliest and go out of season the latest. Every kind of plant and animal thrived notwithstanding the poverty of the soil; and the advantages which nature had denied were, in a great measure, compensated by the effects of skill and industry. It seldom happens that the richest countries are the most productive; or that the bounty of nature, where it has been profusely lavished, is improved by corresponding exertions on the part of man. Repugnant to labour where labour can be dispensed with, it is necessity alone that compels him to earn his bread with the sweat of his brow, and to torture the ungrateful soil for its scanty products. But habits of exertion being once formed, a variety of causes gradually contribute to stimulate his activity and extend his resources. He naturally aspires to improve his condition and circumstances by all the means in his power;—experience soon teaches him better modes of exerting his industry;—as society advances, the natural reward of labour and skill is increased;—and if the public policy of the state be wisely directed to accelerate the operation of natural causes, the most striking results may be produced, and countries originally barren covered with well-cultivated fields, teeming with abundant harvests. Such seems to have been the progression of improvement in Attica; which, though one of the least fertile of the Grecian provinces, was, by the industry and skill of its inhabitants, rendered ultimately one of the most productive in proportion to its extent and the portion of its surface which was susceptible of cultivation.

Chief cities.

The chief cities in the ancient kingdom of Attica were Athens the capital, of which a very full description has been given under that head (see article ATHENS); Eleusis, situated on the gulf of the same name, at an equal distance from Megara and the Peiræus, where the greater mysteries of Ceres were quadriennially celebrated; and, lastly, Rhamnus, famous for the temple of Amphiaræus, and a statue of the goddess Nemesis, executed by Phidias.

Ogyges.

Ogyges has had the reputation of being the first king of Attica; and chronologers have even undertaken to fix the date of his reign, which has been variously set down

at 150 and 200 years before the arrival of Cecrops. But we have no assurance that even the name of Ogyges was known to the older Grecian authors; and if any thing can be gathered from the traditions concerning this fabulous personage, reported by later writers, it is, that, at some very remote period, a flood, having desolated the rich fields of Bœotia over which he reigned, drove many of the inhabitants to establish themselves in the adjoining district of Attica, which, though hilly, rocky, and little fruitful, was yet judged preferable to a champaign country, surrounded on all sides by mountainous tracts, and consequently exposed to a recurrence of the calamity by which so many of them had been overwhelmed. We may therefore safely consign this legendary monarch to that primitive obscurity in which his existence, his origin, and his achievements are equally involved.

At the same time there cannot be a stronger proof of the early civilization of Attica, or at least of its capital city, than the remote period to which its history is carried back in a clear and consistent series. This series commences with Cecrops, an Egyptian, believed to have been contemporary with Moses. Having led into Attica a colony of his countrymen, and brought along with him from Sais the worship of Neith, afterwards called *Athéné*, this adventurer settled on the rock of the Acropolis, which hence received the name of Cecropia, and soon extended his dominion over the whole tract, which was afterwards denominated Attica. He divided his newly-acquired territory into twelve districts, with a principal town or rather village in each, where he caused justice to be administered according to some salutary laws he had established; and he also taught his subjects a more regular and effectual mode of defence against the incursions of their neighbours, from which even their poverty did not exempt them. He fixed his residence in the Cecropia, which was peculiarly under the patronage of the Egyptian goddess, whom the Greeks worshipped by the name of *Athéné*, and the Latins by that of *Minerva*; while many, induced by the proximity of the port and the protection of the fortress, erected their habitations around the base of the latter, and thus gave rise to that city which was destined to become afterwards so illustrious both in arts and in arms. Cecrops is also said to have been the founder of religion as well as laws; to have established the worship of Jupiter, and instituted marriage among the Greeks; to have taught his subjects the arts of ship-building and navigation; to have divided them into four tribes, which were afterwards increased to ten by Cleisthenes; and, finally, to have instituted the celebrated tribunal of Areiopagus.

Among the successors of Cecrops, those whose names have been chiefly recorded in Athenian tradition are, 1. Amphictyon, son of Deucalion of Thessaly, who is said to have succeeded to the throne in right of his wife Atthis, daughter of Cranaus, a native Athenian, who succeeded Cecrops. From Atthis the country, which had hitherto been called Actea, is said to have taken the name of Attica. 2. Erechtheus the First, called by later writers Erichthonius. He set up an image of *Minerva*, made of olive wood, in the Cecropia; and instituted festivals called *Athēnæa* in the Attic cities or head towns of districts, which were then twelve in number. Erechtheus was fabled to have been the son of Neptune and the earth, to have been educated by *Minerva*, to have acted as her assistant in the invention of war-horses and chariots, and to have been

Attica.

His immediate successors.

Attica. buried in the temple which he had dedicated to her in the Cecropia, and which, from this circumstance, was to the latest period known by the name of the Erichtheium. 3. Pandion the First. In his reign lived Triptolemus, who was supposed to have been instructed in the art of husbandry by Ceres, and to have instituted the Eleusinian mysteries. 4. Erechtheus the Second. He colonized a part of Eubœa, and defeated Eumolpus, who, with a body of Thracians, had seized on Eleusis; but he was unhappily slain in the action. The daughters of Erechtheus are said to have devoted themselves to death that their father might prove successful in the Eleusinian war; and about the same time the daughters of Leos were immolated to avert a contagious sickness, in obedience to the Delphic oracle, which prescribed human sacrifices upon the occasion. These and similar remains of barbarism appear from Homer to have prevailed among the Greeks as late as the time of the Trojan war. 5. Ægeus, who, after the direct succession had been considerably disturbed by the collateral branches, recovered the throne, and enjoyed a long reign of thirty-nine years. 6. Theseus. In his way to Athens from Troezen, where he had been living in obscurity, Theseus cleared the country of the robbers who opposed him, and for these exploits was acknowledged by Ægeus and the Athenians as successor to the throne. He afterwards relieved Athens from a disgraceful tribute exacted by the king of Crete; and having succeeded to the royal authority, laid the foundation of the early pre-eminence of his country, by founding the Prytaneium as a court of judicature common to all Attica, and by establishing the Panathenæa in the Erichtheium as a festival for the whole province. The immediate consequence of this change, which occurred about the year B. C. 1300, was the decline of the other eleven Attic cities; a concentration of the government in the town of Athens; and a great increase of population in Attica, attracted by the protection and security resulting from the new laws of Theseus. But these signal benefits, gilded as they were by the brilliant exploits of the patriotic hero, failed to secure him the gratitude of those for whom he had laboured, and fought, and suffered. In consequence of the intrigues of Mnestheus, the son of Pteus, and great-grandson of Erechtheus, he was forced to flee from Athens, and at length died in exile in the island of Scyros.

Mnestheus, Demophon, &c. Mnestheus ascended the throne from which Theseus had been expelled, and reigned twenty-four years. He lost his life at the siege of Troy, and was succeeded by Demophon, one of the sons of Theseus by Phædra, who was likewise present at the siege, but had the good fortune to return in safety. In the reign of the latter prince was erected the famous court of the Ephetæ, consisting originally of fifty Athenians and as many Argives, appointed for the purpose of trying persons accused of the crime of wilful murder. By this court the king himself afterwards submitted to be tried for having accidentally killed one of his subjects. Mnestheus was succeeded by his son or brother Oxyntes, who again was succeeded by his son Aphydes; and this last was murdered by a natural brother of the name of Thymætēs. But the bastard usurper discovered many base qualities unworthy of the station he had assumed, and was at last deposed by his subjects on account of the flagrant cowardice he had displayed on a critical occasion.

Melanthus, Codrus. Thymætēs was appropriately succeeded by a knavish adventurer called Melanthus, who, after a long reign of thirty-seven years, left the kingdom to his son Codrus. The latter reigned twenty-one years, during which period

the Dorians and Heracleidæ had regained all Peloponnesus, and were upon the point of invading Attica. Codrus, being informed that the oracle had promised them victory provided they did not kill the king of the Athenians, came immediately to a resolution of dying for his country. Disguising himself, therefore, as a peasant, he went into the enemy's camp, and having quarrelled with some of the common soldiers, was killed in a brawl. On the morrow the Athenians, knowing what had happened, sent to demand the body of their king, at which the invaders were so terrified that they decamped without striking a blow.

Upon the death of Codrus, a dispute which happened among his sons concerning the succession furnished the Athenians with a pretence for ridding themselves of their kings, and changing the monarchical into a republican form of government. It was highly improbable, they said, that they should ever again have so good a king as Codrus; and, to prevent their having a worse, they resolved to have no king but Jupiter.¹ That they might not, however, appear ungrateful to the family of Codrus, they made his son Medon their supreme magistrate, with the title of archon; an office which was afterwards rendered decennial, but nevertheless continued in the family of Codrus. But the extinction of the Medontidæ having at last left them without restraint, they not only made this office annual, but at the same time created nine archons. By the latter expedient they provided against the exorbitant power of a single person, as by the former they took away all apprehension of the archons having time to establish themselves, so as to be able to change the constitution. In a word, they now attained what they had long sought after, namely, rendering the supreme magistrates entirely dependent upon the people.

There has been handed down to us an enumeration of these archons for upwards of six centuries, beginning with Creon, who lived about 684 years B. C., and coming down to Herodes, who lived only sixty years prior to that era. The first archon of whom we hear any thing really worthy of notice was Draco. He governed about the middle of the 39th Olympiad, when it is supposed he promulgated his laws; but although his name is very frequently mentioned in history, no connected account can be found either of the lawgiver or of his institutions. We only know generally that his laws were excessively severe, awarding the punishment of death for the smallest offences no less than for the most heinous crimes; and that, as Demades remarked of them, they seemed to have been written, not with ink, but with blood. For this extraordinary and indiscriminating severity he gave no other reason than that the smallest faults appeared to him to be worthy of death, and that he could find no higher punishment for the greatest. He was far advanced in years when he legislated for Athens; and he appears to have been vastly conceited of his institutions, which he would not suffer to be called laws, but sanctions, as if they had been emanations of divine wisdom. The Athenians, however, soon grew weary both of the sanctions and their author; upon which Draco was obliged to retire to Ægina, where he was received in the most flattering manner. But the favour of the inhabitants of this place proved more fatal to him than the hatred of the Athenians; for coming one day into the theatre, the audience, to evince their regard for the exiled legislator, threw their cloaks upon him, and fairly stifled the old man to death with their kindness.

Not long after the expulsion of Draco, we find the re-

Mitylenian war.

¹ "It is remarkable," says Mr Mitford, "that Athenian and Roman superstition, without any connection between the people, should have agreed so exactly in the extraordinary circumstance that, after the abolition of royalty among both, and while the very name of king was abhorred as a title of civil magistracy or military command, yet equally the title and the office were scrupulously retained for the administration of religious ceremonies." (*History of Greece*, vol. i. p. 90, London, 1829, 8vo.)

Attica. public engaged in a war with the Mitylenians about the city Sigæum, situated near the mouth of the river Scamander. The Athenian army was commanded by Phrynon, and that of the Mitylenians by Pittacus, one of the seven sages of Greece; but the generals, thinking the honour of their respective countries concerned, and being at the same time desirous to spare the effusion of blood, agreed to settle the dispute by single combat. They met accordingly; but the sage, trusting more to cunning than to courage, concealed behind his shield a net, wherewith he suddenly entangled his antagonist, and easily slew him. This, however, not putting an end to the war, Periander of Corinth interposed; and both parties having submitted to his arbitration, he decreed that Sigæum should belong to the Athenians.

Cylon's conspiracy. About seven years after the Mitylenian war, a conspiracy was entered into by Cylon, son-in-law of Theagenes, prince of Megara, for the purpose of seizing on the sovereignty of Athens. Having consulted the Delphic oracle as to the most proper time, and received directions to make the attempt while the citizens of Athens were engaged in celebrating the great festival of Jupiter, Cylon and his associates made themselves masters of the citadel by a *coup-de-main*, at the time when the greater part of the citizens had repaired to Elis to witness the celebration of the Olympic games. But being instantly besieged by Megacles, who was at that time archon, and soon reduced to great distress from want of water, the chief conspirator and his brother contrived to effect their escape; upon which the remainder fled for safety to the temple of Minerva, where they were barbarously massacred by order of Megacles, and in virtue of one of those sophistical quibbles by means of which men sometimes reconcile their minds to the perpetration of the foulest and bloodiest deeds.

War with Megara. At this period of confusion the Megarensians attacked and took both Nisea and Salamis. The former was a place of little or no importance in any, the latter one of the very greatest in every view; but so completely were the Athenians routed in every attempt to retake it, that a law was at last passed, declaring it capital for any one to propose the recovery of Salamis. About the same time the city was disturbed by reports of frightful appearances, and filled with superstitious fears. The oracle at Delphi was therefore consulted, and an answer returned that the city must be purified by certain expiatory rites. This was accordingly done under the superintendence of one Epimenides, a Cretan, who prescribed the sacrifice of white and black sheep, and also caused many temples and chapels to be erected, including one dedicated to Contumely, and another to Impudence! This man, after looking wistfully for a long time to the port of Munychia, spoke as follows to those that were near him: "How blind is man to the future! For, did the Athenians know what mischief will one day be derived to them from this place, they would eat it with their teeth." This prediction was thought to have been accomplished two hundred and seventy years after, when Antipater constrained the Athenians to admit a Macedonian garrison into that place.

Solon. About 577 years B. C., Solon, the famed Athenian legislator, began to show himself to his countrymen. He is said to have been lineally descended from Codrus, but left by his father in circumstances rather necessitous, which obliged him to apply himself to merchandise. From the first he appeared in the character of a patriot. The shameful decree, that none under pain of death should propose the recovery of Salamis, grieved him so much, that having composed an elegy such as he thought calculated to inflame the minds of the people, he ran into the market-place as if he had been insane, with his night-cap on his head, repeating his verses. A crowd soon col-

Attica. lected around the pretended madman; his kinsman Peisistratus mingled with the people, and observing them moved with Solon's words, agreed to second the patriotic poet with all the eloquence he was master of; and at length they prevailed so far as to have the law rescinded, war declared against the people of Megara, and an expedition immediately fitted out for the recovery of Salamis; which was ultimately effected by a stratagem more creditable to the ingenuity than the bravery of the Athenians.

The success of this enterprise at once established the reputation of Solon; who, on his return to Athens, was greatly honoured by the people, and soon afforded them another occasion of admiring that wisdom for which they had already given him credit. The inhabitants of Cirrha, a town situated in the Bay of Corinth, having repeatedly wasted the territory of Delphi, at last besieged the capital itself, with a view of making themselves masters of the treasures contained in the temple of Apollo. Advice of this intended sacrilege having been sent to the Amphyctyons, or the states-general of Greece, Solon advised that the matter should be universally resented, and that all the states should join in punishing the Cirrhæans, and in saving the Delphic oracle. This suggestion was adopted, and a general war against Cirrha declared. Cleisthenes, prince of Sicyon, commanded in chief, and the Athenian contingent was under the orders of Alcmaeon. Solon accompanied the expedition as assistant or counsellor to Cleisthenes, and under his direction the war was conducted to a prosperous issue. According to Pausanias, the city was reduced by a singular stratagem, said to have been invented by Solon. He caused the river Plistus, which flowed through Cirrha, to be turned into another channel, hoping thereby to distress the inhabitants for want of water; but finding they had many wells within the city, and were not to be reduced by that means, he caused a vast quantity of roots of hellebore to be thrown into the river, which was then suffered to return into its former bed. The inhabitants, overjoyed at the sight of running water, came in troops to drink of it; the consequence of which was, that an epidemic flux ensued, and the citizens being no longer able to defend the walls, the town was easily captured. This, as far as we know, is the only instance on record of a town taken by physic.

On his return to Athens after the hellebore achievement, Solon found things again in the utmost confusion. **Attica.** The remnant of Cylon's faction gave out that all sorts of misfortunes had befallen the republic on account of the impiety of Megacles and his followers; and this clamour was heightened by the retaking of Salamis about the same time by the Megarensians. Solon interposed, and persuading those who were styled "execrable" to abide a trial, three hundred persons were chosen to judge them. The issue was, that the whole of Megacles's party who were alive were sent into perpetual exile, and the bones of such as had died were dug up and sent beyond the limits of their country. But although this decision restored tranquillity for the time, the people soon became divided into three factions, contending about the proper form of government. These were called the Diacrii, Pedieai, and Paralî; the first of whom, consisting of the inhabitants of the hilly country, declared positively for democracy; the second, dwelling in the low country, and far more opulent than the former, were in favour of an oligarchy, supposing the government would fall mostly into their own hands; whilst the third party, who inhabited the sea-coast, were people of moderate principles, and therefore friendly to a mixed government. But besides the agitations occasioned by this difference of political sentiment, disturbances of a much more serious character arose, in consequence of the lamentable condition to which the labouring classes had

Attica. been reduced. According to Plutarch, the poor having become indebted to the rich, either tilled their grounds and paid them the sixth part of the produce, or impignorated their persons for their debts, so that many were made slaves at home, and not a few sold as such into foreign countries; while some were even obliged to sell their children to pay their debts, and others in despair quitted Attica altogether. The greater part, however, were for throwing off the yoke, and began to look about for a leader, openly declaring that they intended to change the form of government, and to introduce an agrarian law.

Solon chosen archon. In this extremity the eyes of all were turned to Solon, and some were for offering him the sovereignty at once; but, perceiving the intentions of these misjudging persons, he behaved in such a manner as to deceive both parties, and showed that he thoroughly understood the character of his countrymen. He refused the sovereignty tendered to him, not because he had any objection to sovereign power, but because he disliked an invidious name; and, preferring the substance to the shadow, he quietly took upon himself, without any pomp or pageantry, the unqualified exercise of the supreme authority of the state, in all its branches, and wielded it with an absolutism which would have been intolerable except under the disguise of republican forms. He was chosen archon without having recourse to the ballot, an anomaly of which there is no other example; and, after his election, he proved the wisdom of the choice which the people had made, by disappointing the interested expectations of all parties. It was a fundamental maxim with Solon, that those laws will be best observed which power and justice equally support. Hence, wherever he found the old constitution in any measure consonant to justice, he refused to make any alteration at all, and was at extraordinary pains to show the reason of such changes as were actually introduced. In a word, being a consummate judge of mankind generally, and, above all, thoroughly conversant with the character of his countrymen, he sought to rule only by showing the people that it was their interest to obey, and contented himself with giving them such institutions as they were prepared to receive, instead of forcing upon them those which might be esteemed theoretically the most perfect. Hence, to one who inquired whether he had given the Athenians the best laws in his power, he replied, "I have established the best which they could receive."

Seisachthia. With reference to the main cause of sedition, namely, the oppressed state of the meaner class, Solon removed it by a scheme which he called *seisachthia*, or discharge. Ancient authors, however, are not agreed as to the precise nature of this contrivance. Some say that he cancelled all debts then in existence, and prohibited the seizure of any man's person in default of payment of a debt for the future; whilst others affirm that the poor were relieved, not by cancelling the debts, but by lowering the interest, and increasing the value of money, so that a mina, which before was equal to seventy-three drachmas only, was by him made equal to a hundred. The more probable opinion is, that the *seisachthia* was a general remittance of all debts whatsoever; for if the fact had been otherwise, Solon could scarcely have boasted, as he did in his verses, that he had removed the marks of mortgages which were everywhere frequent, that he had freed from apprehension such as were driven to despair, and had removed a source of interminable discord and confusion. It must be confessed, however, that there is little ground for the ovation in which the Athenian legislator appears to have indulged. His contrivance, whichever way it be interpreted, was a manifest wrong, which nothing but necessity—and scarcely even that—could have justified. If by the *seisachthia* we are to understand a general remittance of all debts, the nature of the

Attica. proceeding scarcely requires to be characterized. It was an act of open robbery committed on the creditor, who was despoiled and ruined by law in order to relieve the debtor. If, again, its operation was limited to lowering the rate of interest and increasing the value of money, it was still an act of robbery, though the spoliation of the creditor in this case was only partial; while, by disturbing all existing arrangements, and by utterly destroying public confidence, it was evidently calculated to strike at the sources of national industry, and ultimately to aggravate the very evils which it was intended to remedy. In this view it can scarcely be regarded in any other light than as a fraudulent bankruptcy; the less excusable as it seems to have been sanctioned, not so much from the pressure of any immediate necessity, as from a desire to conciliate the multitude, and to secure that hollow popularity which no man ever trusted to without having cause to repent his credulity.

But in the midst of all the glory which Solon acquired by this notable expedient, an accident occurred which for a time clouded his reputation, and had almost entirely ruined his schemes. Having, it seems, consulted Conon, Clinias, and Hipponicus, three of his friends, on an oration he had prepared with a view to engage the people's consent to the *seisachthia*, these worthies, thus apprized of the contemplated measure, availed themselves of their knowledge to borrow large sums of money before the law was promulgated, with the intention, of course, to take advantage of its provisions, and refuse to repay the lenders. We cannot wonder that Solon himself was at first believed to have been cognizant of the scheme, and a partner in this fraudulent adventure. But, happily for his credit, these suspicions were obliterated when it was discovered that the lawgiver was a creditor to a large extent, and likely to become a considerable loser by the operation of his own law. His friends, however, never recovered their credit (it would have been marvellous if they had), but were ever afterwards stigmatized with the opprobrious appellation of *chreiocopidæ* or *debt-sinkers*.

From these and other causes the Athenians were as little pleased with Solon's management as with their former condition; the rich, thinking he had done too much in cancelling the money-debts due to them; and the poor, that he had done too little because he had not made an equal division of the lands of Attica. But, with the fickleness characteristic of democracy, they at length acquiesced in the new institutions, and gave a more public token of their approbation than they had before shown of their displeasure, by instituting a solemn sacrifice under the name of *seisachthia*; at the same time that Solon was unanimously elected legislator of Athens, with full powers to make laws, and to alter or new-model the constitution as he might think fit.

Solon being thus invested with unlimited authority, set about the arduous task of compiling a body of laws for the turbulent people of Attica; and having at last completed his task in the best manner he could, or at least in the best manner that the character of the people would admit, he caused them to be duly ratified, and declared to be in force for a century from the date of their publication. Those which related to private actions were preserved on parallelograms of wood, with cases which reached from the ground, and turned upon a pin like a wheel, whence the appellation of *axones*; and were placed, first in the citadel, and afterwards in the Prytaneium, that all the subjects of the state might have access to consult them whenever they chose. Such as concerned public institutions and sacrifices were inscribed on triangular tablets of stone called *cyrbes*. The Athenian magistrates were sworn to observe both; and in process of time these monuments of Solon's wisdom became so famous that all public acts

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were from them named axones and cyrbes. With regard to the axones or *jus privatum* of Solon, our information is exceedingly imperfect; but if it be true that the decemviral constitutions were principally borrowed from this portion of his code, the fragments which remain of these celebrated laws are certainly calculated to give us no mean idea of his fitness for the task which circumstances as well as inclination had induced him to undertake. Nor will our opinion of the legislator be lowered by attending to his system of public law; concerning which more exact details have been preserved, and some account will be given when we come to speak of the Athenian government.

After the promulgation of his code, Solon found himself obliged to leave Athens, to avoid being continually teased for explanations and emendations of his laws; an annoyance, it is to be feared, with which all codificators, modern as well as ancient, must lay their account. He therefore pretended an inclination to merchandise, and obtained leave to withdraw himself for ten years, in the hope that during the period of his absence his laws would grow familiar to the people. From Athens Solon accordingly travelled into Egypt, where he conversed with Psamemphus of Heliopolis and Sesonchis of Sais, the most learned priests of that age, from whom he learned the situation of the island Atlantis, and wrote an account of it in verse, which Plato afterwards continued. Leaving Egypt, he visited Cyprus, where he was well received by one of the petty kings, and assisted in the foundation of a new city, the site of which he had pointed out, and which, out of gratitude to the Athenian legislator, was called Solos.

But while Solon was thus travelling in quest of wisdom, which is not always found in the course of tours and perambulations, his countrymen, resolved on being dissatisfied at all events, had again divided themselves into three factions. Lycurgus was at the head of what may be called the country party; Megacles the son of Alcmaeon swayed those who lived on the sea-coast; and Peisistratus appeared as the champion of the poorer sort, under the pretence of protecting them from tyranny, but in reality with the view of seizing on the sovereignty for himself. All these factions pretended to have a prodigious regard for Solon and his laws, at the same time that they were secretly desirous of a change; but in what way they were to be benefited by a counter-revolution none of them knew, or even pretended to know. An abstract love of change for its own sake, rather than any definite purpose of improvement, seems to have been the ruling principle of these factions; nor was the agitation produced the less violent because no one knew exactly what it was he desired. In the midst of all this confusion the legislator returned. Each of the factions paid their court to him; affecting to receive him with the deepest reverence and respect, and beseeching him to resume his authority, and compose the disorders to which they themselves had given birth. But Solon declined this hollow invitation, on the ground that his age rendered him unable to speak and act as formerly for the good of his country: he however sent for the chiefs of each party, and entreated them in the most pathetic manner not to ruin their common parent, but to prefer the public good to their own private interest; sound advice, doubtless, but, like most sage admonitions, entirely thrown away on those to whom it was administered.

Peisistratus.

Peisistratus, who of all the chiefs had unquestionably the least intention of following Solon's advice, appeared to be the most affected with his discourses; but perceiving that he affected popularity by all possible methods, Solon easily penetrated into his design of assuming the sovereign power. This he spoke of privately to Peisistratus himself; but as he saw that his admonitions had no effect, he unveiled the designs of this ambitious chief, that the public

might be on their guard against him and his artful machinations. But all the wise discourses of Solon were lost upon the Athenians. Peisistratus had got the meaner sort entirely at his devotion, and therefore resolved to cheat them out of the liberty which they could not appreciate, and deserved to lose. With this view he wounded himself, then drove into the market-place, and there showed his bleeding body, imploring the protection of the people against those whom his kindness to them had rendered his implacable enemies. It was for being their declared friend, he said, that he had thus suffered. They saw it was no longer safe for a man to be a friend to the poor; they saw it was no longer safe for a man to live in Attica, unless they would take him under that protection which he implored. A crowd being instantly collected, Solon came among the rest, and, suspecting the deceit, openly taxed Peisistratus with his perfidious conduct; but to no purpose. A general assembly of the people was summoned, wherein it was moved that Peisistratus should have a guard. Solon was the only person present who had resolution enough to oppose this measure; the richer Athenians remaining silent through fear of the multitude, which implicitly followed Peisistratus, and applauded every thing he said. But when he saw that all his endeavours were vain, he left the assembly, remarking as he withdrew, that he was wiser than some, and stouter than others. A guard of four hundred men was then unanimously decreed to Peisistratus; and with this inconsiderable body he managed, partly by stratagem and partly by force, to possess himself of the supreme power, B. C. 560. Solon inveighed bitterly against the meanness of his countrymen, in thus tamely surrendering their liberties, and attempted to rouse them to take up arms in defence of the constitution and the laws; but finding his efforts unavailing, he withdrew, remarking that he had done his utmost for his country; and immediately retired from the dominion of Athens, to which he refused to return, even at the solicitation of Peisistratus himself.

Peisistratus, having thus obtained the sovereignty, did not overturn the laws of Solon, but on the contrary used his power with the greatest moderation. It was not in the nature of things, however, that the Athenians could long remain satisfied with any form of government. On the usurpation of Peisistratus, Megacles and his family had retired from Athens, ostensibly in order to save their own lives; but having entered into a treaty with Lycurgus, whom they brought, along with his party, into a scheme for deposing the usurper, they concerted matters so skilfully, that Peisistratus was soon after obliged to withdraw from the city; and, on his departure, the Athenians ordered his goods to be confiscated. But Megacles had no sooner succeeded in his project against Peisistratus, than, finding his ally Lycurgus untractable, he changed sides, like a thorough-paced intriguer, and began to plot the return of the very man whom he had just succeeded in expelling as a tyrant and usurper. And in this counter-project, as may easily be supposed, he found an able coadjutor in Peisistratus himself, whose recall was at length effected by means of a trick worthy of the parties engaged in this little political drama, and eminently characteristic of a people who resorted to finesse in every thing, and were always content to be gulled, provided the thing was cleverly executed. Having found out a woman of the name of Phya, of a mean family and fortune, but of great stature and very handsome person, they dressed her in armour, placed her in a chariot, and having disposed things so as to make her appear to the utmost advantage, they conducted her towards the city, sending heralds before, with orders to address the people in the following terms: "Give a kind reception, O Athenians, to Peisistratus, who is so much honoured above all other men by Minerva, that she her-

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Attica. self condescends to bring him back to the citadel." The report being universally spread that Minerva was bringing back Peisistratus, and the ignorant multitude believing this woman to be the goddess, addressed their prayers to her, and received Peisistratus with the utmost joy. When he had recovered the sovereignty, Peisistratus married the daughter of Megacles, in fulfilment of a stipulation made between them to that effect, and also gave the mock goddess as a wife or mistress to his son Hipparchus.

Second expulsion. But unfortunately Peisistratus did not long enjoy the authority to which he had been restored in this creditable manner. He had indeed married the daughter of Megacles according to treaty; but having children by a former marriage, and remembering that the whole family of Megacles were execrated by the Athenians, he thought it expedient to suffer his new spouse to remain in a state of perpetual widowhood. This the lady bore patiently for some time; but at last acquainting her mother with the state in which she was compelled to live, the affront was highly resented; and Megacles immediately entered into a treaty with the malcontents, of whom there was always a great number at Athens under every form of government. Peisistratus, apprized of this step on the part of his father-in-law, and perceiving that a new storm was gathering, voluntarily quitted Athens and retired to Eretria; where, having consulted with his sons, he resolved to reduce Athens, and repossess himself of power by force of arms. With this view he applied to several of the Greek states, including that of Thebes, who furnished him with the troops he desired; and at the head of a considerable force he returned to Attica,—reduced Marathon, the inhabitants of which had taken no measure for their defence,—surprised and routed the republican forces, which had marched out of Athens to attack him,—and finally re-established himself in power, by using victory with his accustomed moderation.

Return. Peisistratus being thus reinstated once more in the sovereignty, took a method of securing himself in power directly opposite to that which Theseus had adopted. For, instead of collecting the inhabitants from the country into towns, as his predecessor had done, Peisistratus, made them retire from the towns into the country, in order to apply themselves to agriculture; and thus prevented their meeting together in bodies and caballing against him as they had hitherto been accustomed to do. By this means also the territory of Athens was greatly ameliorated, and extensive plantations of olives were reared over all Attica, which had hitherto been not only destitute of corn, but also naked and bleak in appearance from the total want of trees. And had he stopped here it would have been well. But actuated by that partiality for sumptuary laws which seems to have been the foible of nearly all the ancient legislators, he commanded his subjects in the city to wear a kind of sheepskin frock reaching to the knees, and appears to have set great store by this absurd enactment, which was doubtless intended to restore the simpli-

city of ancient manners. The Athenians, however, vehemently resented this interference with their *habits*; and so odious did the sheepskin garment become, that in succeeding times the frock or jacket of Peisistratus was a sort of by-word for the badge or garb of slavery. Experience shows that it is comparatively an easy matter to rob men of their liberty, and trample both on their political and civil rights; but an interference with their private habits or the adornment of their persons is almost always dangerous. As prince of Athens, Peisistratus exacted for the service of the state the tenth part of every man's revenue, and even of the fruits of the earth; a heavy tax, undoubtedly, and one which might well justify a little grumbling on the part of those who had to pay it; nor could all the magnificence with which the public revenue was expended reconcile the Athenians to the heavy burdens they were called upon to bear. Indeed they not unnaturally fancied themselves oppressed by tyranny, and indulged in perpetual complaints from the time Peisistratus first ascended the throne to the day of his death; which happened about thirty-three years after he had first assumed the sovereignty, of which period, according to Aristotle, he reigned about seventeen years.¹

Attica. In taking a retrospect, however, of the government and character of this celebrated man, it is impossible to doubt that the one was enlightened and the other humane. The ancient writers are all agreed that he made no change of any consequence in the Athenian constitution. All the laws continued in force; the general assembly, the council of state, the courts of justice, and the magistracies, respectively retained their constitutional powers; and it is known that the usurper himself obeyed a citation from the Areiopagus upon a charge of murder. His hand, it is true, lay heavy on the purses of the people in the matter of taxation. But the sums which he raised were religiously expended in the decoration and improvement of the capital, or in works of public utility; and it cannot be questioned that, although he resorted to iniquitous or contemptible expedients to obtain power, he never abused it, either for the gratification of selfishness or revenge. "Take away only his ambition," said Solon; "cure him of the lust of reigning, and there is not a man more naturally disposed to every virtue, nor a better citizen, than Peisistratus." He embellished the city with a great variety of edifices; he improved and strengthened its defences; he enlarged and ameliorated its harbours; and by various acts of taste and magnificence, not less than by his attention to the cultivation of the public mind, he may be said to have fixed the muses at Athens. In a word, if he was ambitious he was also enlightened and humane; and although no one can justify the modes which he took to possess himself of power, his use of it was characterized by a moderation and patriotism which have never as yet been exemplified by any other usurper, ancient or modern; insomuch that, reviewing his character and conduct, we are almost tempted to

The government of Peisistratus, as we have seen, resolves itself into three distinct periods, interrupted by two exiles. Aristotle and Herodotus both agree in this. Further, the term of one exile being ten or eleven years, that of the other must have been five or six. Thus far all is clear. But the duration of his three periods of government, especially of the first and third, is not so satisfactorily ascertained; and chronologers have accordingly adopted various schemes for the arrangement of these periods. Corsini, Barthélemy, Larcher, and Du Fresnoy, make the first tyranny one year; Blair and Clavier make it two and ten years respectively. Corsini and Blair make the first exile one year; Barthélemy two; Larcher, Clavier, and Du Fresnoy, five years. Larcher, Blair, and Du Fresnoy, make the second tyranny one year; Corsini and Clavier four and two years respectively. Corsini states the duration of the second exile at fourteen; Larcher, Blair, Clavier, and Du Fresnoy, at only eleven years. Corsini makes the third tyranny twelve, Larcher fifteen, Blair eighteen, Clavier five, and Du Fresnoy fifteen; while Barthélemy estimates the second tyranny, the second exile, and the third tyranny, as extending together to thirty years. We may remark, however, that those chronologers, as Corsini, Blair, and Barthélemy, who make the first exile less than five years, are at variance with the authorities; and that Corsini, in particular, is inconsistent in his dates, since, according to his own principles, the second exile should be eleven years, instead of fourteen, which last number alone accords with his arrangement. Larcher, Clavier, and Du Fresnoy, rightly give the two exiles at $5 + 11 = 16$ years; but they differ materially in the duration of the first and last tyranny; nor on this point is it easy to decide between them. It is almost superfluous to add, that the general results of these different evaluations coincide, with the exception of that given by Corsini, which is 32, or one year less than the others. (Clinton's *Fasti Hellenici*, Appendix, No. ii. p. 180; Oxford, 1824, 4to.)

Attica.
Hipparchus and
Hippias.

subscribe to the sentiment expressed by the poet Claudian, *Nunquam gravior extat libertas, quam sub rege pio.*

Peisistratus left behind him two sons, Hipparchus and Hippias, both men of abilities, who shared the government between them, and behaved for a time with lenity and moderation. But though, by the mildness of their government, the family of the Peisistratidæ seemed to be fully established on the throne of Athens, a conspiracy was unexpectedly formed against the brothers, by which Hipparchus was slain, and Hippias narrowly escaped death. There were at that time living in Athens two young men, called Harmodius and Aristogeiton. The former being remarkable for his personal beauty, was, on that account, it is said, unnaturally beloved by the other, and also by Hipparchus, who, if we may believe Thucydides, actually forced him. This was vehemently resented by Aristogeiton, who, in consequence, determined on revenge, which another circumstance contributed to accelerate. Hipparchus, finding that Harmodius endeavoured on all occasions to shun him, publicly affronted the youth, by refusing permission to his sister to carry the offering of Minerva, as if she had been a person unworthy of that distinction. The two young men, not daring to show any public signs of resentment, consulted privately with their friends, amongst whom it was resolved, that at the approaching festival of the great Panathenæa, when the citizens were allowed to appear in arms, they should attempt to restore Athens to its former liberty; and in this they imagined they would be seconded by the whole body of the people. But when the appointed day arrived, they perceived one of their number talking familiarly with Hippias; wherefore, dreading a discovery, they immediately fell upon Hipparchus, and dispatched him with many wounds. In this exploit, however, the people were so far from aiding the conspirators, that they suffered Harmodius to be killed by the guards of Hipparchus; and seizing Aristogeiton, delivered him up to the vengeance of Hippias. But with their usual fickleness, they soon changed

their opinion, and some time afterwards paid the most extravagant honours to the memory of these conspirators; causing their praises to be sung at the great Panathenæa, forbidding any citizen to call a slave by either of their names, and erecting brazen statues to them in the agora or market-place.¹ Several immunities and privileges were also granted to the descendants of these (so called) patriots, and all possible means were taken to render their memory respected and revered by posterity.

Hippias being now sole master of Athens, and burning to revenge the murder of his brother, began by torturing Aristogeiton, in order to force him to disclose his accomplices. But this proved fatal to his own friends; for Aristogeiton impeaching such only as he knew to be best affected to the government of Hippias, the latter were instantly put to death without further inquiry; and when he had exhausted his list, he at last told Hippias, that he now knew of none who deserved to suffer death except the tyrant himself. Hippias next vented his rage on a woman named Leaina, who had been kept by Aristogeiton, and who was put to the torture; which, however, she had the courage to endure without making any confession. After the conspiracy was thought to be quashed, Hippias set about strengthening his government by every means he could think of. With this view he contracted alliances with foreign princes; he increased his revenues by different expedients; he married his only daughter, Archedice, to Æantides, son of Hippocles, tyrant of Lampsacus; and he endeavoured, by affecting various arts of popularity, to conciliate that public opinion which his excessive severities had so rudely shocked. But all these precautions proved fruitless. The lenity of the government of Peisistratus had alone supported it; and although Hippias had fewer difficulties to contend with than his father, the vehemence of his resentment on account of his brother's murder betrayed him into courses repugnant alike to sound policy and to the interests of his family, and at last proved the

¹ However much we may be shocked at the alleged cause of this tyrannicide, it is impossible not to admire the beautiful verses, ascribed to Kallistratus, in which the act of supposed patriotic immolation is commemorated. The *Ἀρμόδιου μίλος* has, in fact, shed around the affair a ray of glory which does not in truth belong to it, when viewed in its proper light. The song, accompanied with a translation nearly literal, is subjoined:—

Εν μυρτου κλαδι το ξίφος φέρησω
'Ὡς περ Ἀρμόδιος κ' Ἀριστογείτον,
'Ὅτε τον τυραννον κτανίτην
Ἰσονόμους τ' Ἀθῆνας ἐποίησατην.

Φίλταθ' Ἀρμόδι', οὐ τι που τίθηκας
Νησοῖς δ' ἐν μακάρων σὶ φασιν εἶναι
'Ἰνα περ ποδωκῆς Ἀχιλλεύς,
Τυδεΐδην τε φασιν Διομήδεα.

Εν μυρτου κλαδι το ξίφος φέρησω,
'Ὡς περ Ἀρμόδιος κ' Ἀριστογείτον,
'Ὅτ' Ἀθηναίης ἐν θυγατρὶ
Ἄνδρα τυραννον Ἰππάρχον ἐκαινέτην.

Λαί σφ' ὦν κλέος ἔσσεται κατ' αἶαν,
Φίλταθ' Ἀρμόδι' κ' Ἀριστογείτον,
'Ὅτε τον τυραννον κτανέτην
Ἰσονόμους τ' Ἀθῆνας ἐποίησατον.

"This song," says Mr Mitford, "the most ancient composition of its kind extant, may be seen, with an elegant Latin translation, in Bishop Lowth's *Lectures on Hebrew Poetry*." (*History of Greece*, vol. i. p. 508, 509, note. London, 1830, 8vo.) A Latin translation by Bishop Lowth could scarcely fail to be elegant; but in no edition of the *Lectures* with which we are acquainted has any translation of this song, either in whole or in part, been attempted. After quoting the Greek, however, the accomplished prelate just named remarks, "Quod si post Idus illas Martias e Tyrannoctonis quispiam tale aliquod carmen plebi tradidisset, inque Suburram, et fori circulos, et in ora vulgi intulisset, actum profecto fuisset de partibus, deque dominatione Cæsarum: plus mehercule valuisset Ἀρμόδιου μίλος, quam Ciceronis Philippicæ omnes." (*De Sacra Poesi Hebræorum*, præf. i. p. 10. Oxon. 1753, 4to.) The translation above attempted has little to recommend it except its literal closeness, in as far at least as the somewhat unmanageable nature of the proper names would admit. A free paraphrase would have allowed more poetical embellishment, but would not have answered the historical purpose which we had in view. Executed in this manner, the last quatrain, for example, might have been rendered thus:—

Oh, glory shall follow thee ever and ever,
And song shall enshrine in its numbers thy name;
Nor till Athens and liberty finally sever,
Will the halo grow dim that encircles thy fame.

I'll wreath a beauteous myrtle bough,
As did Harmodius, round the sword,
When he of old the tyrant slew,
And Athens' equal laws restored.

Ne'er shalt thou die, Harmodius, ne'er,
For in the blessed isles they tell
That thou hast gone, beloved one, where
Diomed and Achilles dwell.

With myrtle will I wreath my sword,
As at Minerva's festival,
Harmodius, when the despot lord
Beneath thy sword was doomed to fall.

Oh, glory shall for ever crown
Thee, loved Harmodius, for thy sword
The tyrant unto death struck down,
And Athens' equal laws restored.

Attica.

Cruelty of
Hippias.

Attica. cause of his expulsion from power in rather less than four years after the death of Hipparchus. This revolution was principally brought about by the party of the Alcmaeonidæ, by which name the adherents of Megacles became known after the death of that inveterate intriguer. Hippias retired to Sigæum, an appanage of his family, where he seems to have died, without making any vigorous or effectual effort to recover his lost authority.¹

State of Athens. After the expulsion of the Peisistratidæ, the Athenians did not long enjoy the tranquillity which they had promised themselves. They became divided into two factions; one of which was headed by Cleisthenes, chief of the Alcmaeonidæ; and the other by Isagoras, a man of quality, and highly in favour with the Athenian eupatrids or nobility. Cleisthenes cultivated the people, and endeavoured to gain their affection by increasing as much as possible their power; whilst Isagoras perceiving that the popular arts of his rival would secure him an ascendancy, applied to the Lacedæmonians for assistance; at the same time reviving the old story of Megacles's sacrilege, and insisting that Cleisthenes ought to be banished as being of that person's family. Cleomenes king of Sparta readily entered into his schemes, and suddenly dispatched a herald to Athens with orders to declare war provided all the Alcmaeonidæ were not immediately banished. The Athenians had the pusillanimity to comply with this insolent requisition, and to banish Cleisthenes with all his relations. But their base poltroonery and ingratitude did not answer their purpose. Cleomenes entered Attica at the head of a Spartan army; and arriving at Athens, condemned to banishment seven hundred families, in addition to those previously sent into exile. And, not content with this, he would have dissolved the senate, and vested the government in the heads of the faction of Isagoras; but happily the Athenians were not yet degraded enough to submit to such humiliation; so, taking up arms, they drove the Spartan troops into the citadel, where, after sustaining a short siege, Cleomenes surrendered, on condition that all who were in the castle should retire unmolested; a stipulation which was shamefully violated on the part of the Athenians.

The Spartan king, however, had no sooner withdrawn from Athens, than he formed a strong combination in favour of Isagoras; having engaged the Bœotians to attack Attica on the one side, and the Chalcidians on the other, whilst he at the head of a powerful Spartan army entered the territory of Eleusis. But this powerful confederacy was quickly dissolved. The Corinthians, who had joined Cleomenes, doubting the justice of their cause, returned home: the rest of his allies likewise began to waver; and his colleague Ariston, the other king of Sparta, differing in opinion with Cleomenes, the latter was obliged to abandon the enterprise. The Spartans and their allies having withdrawn, the Athenians quickly routed the Bœotians and Chalcidians, and carried off a great number of prisoners, who were afterwards set at liberty on paying a ransom of two minæ a head. The Bœotians, on the other hand, immediately vowed revenge, and engaging on their side the people of Ægina, who had a hereditary hatred of the Athenians, the Æginetans landed a considerable army, and ravaged the coasts of Attica while the Athenians were occupied with the Bœotian war.

Attempt to restore Hippias. In the meanwhile Cleomenes, exasperated by his unsuccessful expedition against Attica, and anxious for an

Attica. opportunity of effacing the remembrance of his defeat, produced at Sparta certain pretended oracles which he alleged he had found in the citadel of Athens while he was besieged therein, the purport of which was, that Athens would soon become a rival of Sparta. At the same time it was discovered that Cleisthenes had bribed the priestess of Apollo to cause the Lacedæmonians to expel the Peisistratidæ from Athens; which was sacrificing their best friends to those whom interest necessarily rendered their enemies. This pitiful jugglery had such an effect, that the Spartans repenting their folly in expelling Hippias, sent for him from Sigæum, in order to restore him to his principality; but the other states refusing to countenance the projected restoration, the Spartans were forced to abandon the enterprise, and Hippias returned to Sigæum to digest his disappointment with what appetite he might.

About this period Aristagoras the Milesian, having Persian stirred up a revolt in Ionia against the Persian king, applied to the Spartans for assistance; but sickened already with bootless crusades of this description, they declined to have any hand in the matter; and it would have been well if the Athenians, to whom the disturber next made application, had followed this wise and prudent course. One would have thought that their own intestine broils, aggravated by the interference of the Lacedæmonians, might have indisposed them to foment disturbances in other countries, against the government of which they had no ground or even pretence for complaint. But the fact proved otherwise; and Aristagoras was by them furnished with twenty ships, under the command of Melanthus, a nobleman universally esteemed.² This rash action cost the Greeks very dear; for no sooner did the king of Persia hear of the assistance sent from Athens to his rebellious subjects, than he declared himself the sworn enemy of that city, and solemnly besought the deity that he might one day have it in his power to be revenged on them. But besides the displeasure which Darius had conceived against the Athenians on account of the assistance they had afforded the Ionians, he was further encouraged, by the intrigues of the ex-tyrant Hippias, to undertake an expedition against Greece. Immediately on his return from Lacedæmon, as above related, Hippias passed over into Asia; proceeded to Artaphernes, governor of the adjacent provinces belonging to the Persian king; and excited him to make war upon his country, promising to do homage to the Persian monarch provided he was restored to the principality of Athens. Apprized of this step on the part of their late tyrant, the Athenians sent ambassadors to Artaphernes, desiring permission to enjoy their liberty in peace. But the Persians returned for answer, that if they would have peace with the Great King, they must immediately consent to receive Hippias; and as the Athenians were by no means disposed to purchase the forbearance of the Persian monarch at the price of compliance, they resolved to assist his enemies by every means in their power. This resolution being made known to Darius, he commissioned Mardonius to avenge him of the insults which he thought the Greeks had offered him; but that commander having met with a storm at sea and other accidents, which rendered him unable to do any thing, Datis and Artaphernes (the son of the Artaphernes above mentioned) were commissioned to chastise Grecian insolence and presumption.

¹ The Peisistratidæ were expelled before the fourth year of Hippias was completed, eighteen years after the death of Peisistratus, twenty years before the battle of Marathon, a hundred years before the constitution of the Four Hundred, and B. C. 510. (Herodotus, v. 55; Thucydides, vi. 59, and viii. 68; Plato, *Hipparch.* p. 229; Schol. *Lysistrat.* 619; *Fasti Hellenici*, 16.)

² Herodotus, v. 37, 38, 55, 97, 98, 99. Charon Lampsacenus apud Plutarch. *Mor.* p. 861; *Fasti Hellenici*, p. 20. Aristagoras was slain in Thrace, B. C. 497.

Attica.
Persians
invade
Greece.

War being thus declared, the Persian commanders, fearing again to attempt doubling the promontory of Athos, where their fleet had formerly suffered, drew their forces into the plains of Cilicia, and passing thence, through the Cyclades to Eubœa, directed their course towards Athens. Their instructions were to destroy both Eretria and Athens, and to bring away the people. The first attempt was made on Eretria; and on the approach of the Persian fleet the inhabitants sent to Athens to apply for assistance. Nor did they sue in vain. With a magnanimity almost unparalleled, considering the crisis, the Athenians sent 4000 men to their aid; but unhappily the Eretrians were so greatly divided in opinion, that, though the danger was urgent, nothing could be resolved on. One party was for receiving the Athenian succours into the city; another declared for abandoning the city and retiring into the mountains of Eubœa; whilst a third was base enough to seek to betray their country to the Persians. Matters being in this hopeless state, the Athenian commanders withdrew the auxiliary force, and retiring by Oropus, escaped the destruction with which they were threatened; whilst Eretria, betrayed into the hands of the Persians, was pillaged, burned, and its inhabitants sold for slaves; a fate which their cowardice and treachery richly merited.

Battle of
Marathon.

On the tidings of this disaster the Athenians immediately drew together such forces as they could muster, amounting in all to about 10,000 men; and these, with 1000 Plataeans who afterwards joined them, were commanded by ten general officers, with equal power, amongst whom were the illustrious names of Miltiades, Aristides, and Themistocles, men distinguished alike for their valour, their conduct, their patriotism, and their virtue. But it being generally thought that so small a body of troops would be unable to resist the formidable power of the Persians, a messenger was dispatched to Sparta to entreat the immediate assistance of that state. He communicated his business to the senate in the following terms:—"Men of Lacedæmon," said he, "the Athenians desire you to assist them, and not to suffer the most ancient of all the Grecian cities to be enslaved by the barbarians. Eretria is already destroyed, and Greece consequently weakened by the loss of so considerable a place." The assistance was readily granted; but the promised succours arrived too late for the occasion which required them; and, happily for their own glory, the Athenians were obliged to fight without waiting for their arrival. In the memorable engagement on the plains of Marathon, whither Hippias had conducted the Persian host, the latter were defeated with great loss by the Athenian infantry, under the command of Miltiades, and driven to their ships.¹ They then endeavoured to double Cape Sunium (Colonna), in order to surprise Athens before the army could return. But in this they were prevented by Miltiades, who, leaving Aristides with 1000 men to guard the prisoners, returned so expeditiously with the main body, that he reached the temple of Hercules before the barbarians had time to commence a serious attack on the city. In the meanwhile the virtuous Aristides discharged the trust reposed in him with the strictest integrity. Though there was much gold and silver in the Persian camp, and the tents and ships they had taken were filled with all manner of riches, he not only forbore taking any thing for his own

use, but exerted himself to the utmost in order to prevent others from appropriating the spoils of the enemy, which were religiously reserved for the public service of the state.

After the victory of Marathon, the inhabitants of Plataea were declared free citizens of Athens, and Miltiades, Themistocles, and Aristides were at first treated with all possible marks of admiration and respect. But the gratitude of nations, more especially of republics, is proverbially short-lived. Miltiades having undertaken the command of an expedition against the island of Paros, in which he proved unsuccessful, he was, on his return, accused and condemned in a fine of fifty talents, the whole expense of the expedition; and, being unable to pay so large a sum, he was barbarously thrown into prison, where he soon after died of a wound received in the service of his country. Nor did Aristides fare much better than his illustrious colleague. Miltiades had proposed an expedition, which failed, and in which it was possible he might have had sinister designs; but against Aristides not so much as even a suspicion of guilt could with any plausibility be alleged. On the contrary, his extraordinary virtue had procured him the title of The Just, and he had never been found to swerve from the maxims of strict equity. His downfall was occasioned by the intrigues of Themistocles; who being a man of great abilities, and hating Aristides on account of the character which the latter deservedly bore among his countrymen, took all opportunities of insinuating that his rival had in reality made himself master of Athens without the parade of guards and royalty. "He gives laws to the people," said he; "and what constitutes a tyrant but giving laws?" By this strange kind of reasoning a strong party was formed against him, and it was resolved to banish him for ten years by the ostracism. In this species of ballot the name of the accused was written upon a shell by every one who desired his exile, and this conch was carried to a certain place in the agora, inclosed by means of rails. If the number of shells so collected exceeded six thousand, the sentence was inflicted; if it fell short of this number, the accused was exonerated from the charges against him. When the agents of Themistocles had sufficiently accomplished their purpose, the people suddenly flocked to the market-place, loudly demanding the ostracism. On this occasion a clown, who had just come from some place in the country, bringing a shell to Aristides, said to him, "Write me Aristides upon this." Aristides, surprised, asked him if he knew any ill of that Athenian, or if he had ever done him any hurt? "Hurt me!" replied the rustic, "no, I don't so much as know him; but I am weary and sick at heart from hearing him everywhere called The Just." The reason was unanswerable. Aristides took the shell; wrote his own name upon it; and when informed that the ostracism had fallen upon him, modestly retired from the agora, saying, as he withdrew, "I beseech the gods that the Athenians may never see the day which shall force them to remember Aristides."²

About three years after the banishment of this virtuous citizen, Xerxes king of Persia sent to demand of the Greeks earth and water as tokens of submission and homage. But Themistocles, desirous to widen the breach with that monarch, put to death the interpreter for publishing the decree of the king of Persia in the language

¹ For an account of the memorable battle of Marathon, with military details of the Greek armies, including the Athenian, see the article ARMY. "The Athenians who fought at Marathon," says Herodotus, "were the first among the Greeks known to have used running for the purpose of coming at once to close fight; and they were the first who withstood (in the field) even the sight of the Median dress and of the men who wear it; for hitherto the very name of Medes and Persians had been a terror to the Greeks." This honest confession seems to have given great offence to Plutarch, but it is confirmed by Plato (*in Menexen.* l. ii. p. 240) and other writers of the highest authority.

² The ostracism of Aristides took place B. C. 483, since he was recalled *πρῶτον καὶ ἐξέβη διὰ Θισπυρίας ἐλαυνόντος.* (Plutarch, *Aristid.* c. 8.) Some, however, think that it took place the following year; and, in fact, he seems to have been in exile at the time of the

Attica. of the Greeks; and having prevailed with the several states to lay aside their animosities and provide for their common safety, he got himself elected general of the Athenian army.

When the news arrived that the Persians were advancing to invade Greece by the Straits of Thermopylæ, and that with this view they were transporting their forces by sea, Themistocles advised his countrymen to abandon the city, embark on board their galleys, and encounter their enemies while yet at a distance. But this advice being disregarded, Themistocles put himself at the head of the army, and having joined the Lacedæmonians, marched towards Tempe. Here intelligence was received that the Straits of Thermopylæ had been forced, and that Bœotia and Thessaly had submitted to the Persians; and the army in consequence returned without attempting any thing. In this extremity the oracle at Delphi was consulted by the Athenians, and at first returned a very alarming response, threatening them with total destruction; but after much humiliation, a more favourable answer was obtained, in which, probably by the direction of Themistocles, they were promised safety in *walls of wood*. This being interpreted as a command to abandon Athens, and place all their hopes of safety in their fleet, the greater part began to prepare for embarkation, and money was distributed among them by the council of the Areiopagus, to the amount of eight drachmas a head; but this not proving sufficient, Themistocles publicly gave out that somebody had stolen the shield of Minerva; and, under pretence of searching for the lost ægis, he seized on all the money he could find. Some, however, still refused to embark, and understanding the oracle in its literal sense, raised fortifications of wood, resolving to wait the arrival of the Persians, and defend themselves to the last. About this time Aristides was recalled, not so much, it is said, from a sense of the injustice which had been done to him, as from a groundless apprehension of his going over to the Persians and assisting them with his advice.

Capture of Athens. The Persians having advanced to Athens soon after the inhabitants had deserted it, met with no opposition except from the few who had resolved to remain; and as they would listen to no terms of accommodation, they were put to the sword, and the city utterly destroyed. Xerxes, however, being defeated in a great naval engagement at Salamis, was forced to fly with prodigious loss. Themistocles was for pursuing him and breaking down the bridge of boats which he had thrown over the Hellespont; but this advice being overruled, the crafty Athenian sent a trusty messenger to the king, acquainting him that the Greeks intended breaking down his bridge, and at the same time suggesting the propriety of his making all haste in order to prevent his retreat being cut off. This advice, though misinterpreted by some, was certainly a prudent one, as Xerxes, although he had sustained a defeat, was still at the head of an army capable of destroying all Greece; and had he been driven to despair by finding himself shut up or even too hotly pursued, it is impossible to say what might have been the event. "Make a bridge of gold for a flying enemy," is a rule which the experience of war in all ages has sanctioned.

The defeat of Xerxes at Salamis disposed Mardonius, who had been left to carry on the war by land, rather to treat with the Athenians than to fight them; and with this view he sent Alexander, king of Macedon, to Athens to propose an alliance with the republic, exclusively of the other Grecian states. But this proposal was rejected; in

consequence of which Athens was a second time destroyed,¹ and the Athenians were forced to retire to Salamis. But they were soon freed from the apprehension of final subjugation by the total defeat and death of Mardonius at Plataea, where Aristides and the Athenian troops under his command particularly distinguished themselves. And, by a singular coincidence, on the same day that the battle of Plataea was fought, another division of the Persians was defeated at Mycale in Ionia, where the Athenians also behaved with more signal gallantry than any of the other Greeks. The Persians being thus disposed of, the troops who had fought at Mycale crossed over to the Chersonesus, and laid siege to Sestos, which they at length captured after an obstinate defence by the garrison; a circumstance which appears to have irritated them so much that they put both the commanders to death in the most barbarous manner. One of them, Oibazus, was sacrificed to a Thracian god; whilst the other, Artyactes, was impaled alive, and his son stoned to death before his face, on the absurd pretence that he had rifled the sepulchre of Protesilaus.

After the victories of Plataea and Mycale the Athenians, City re-freed from all apprehension respecting the Persians, began to rebuild their city in a more magnificent manner ^{re-built and fortified.} But, as usual, disputes immediately arose about the form of government most proper to be adopted, and threatened to plunge the city into anarchy. The commons, with Themistocles at their head, declared for a democracy; whilst Aristides, dreading the inconstancy of a purely popular government, wished to organize a kind of mixed administration, but withdrew his opposition when he found the general opinion hostile to his views. Accordingly it was proposed that every citizen should have an equal right to the government, and that the archons should be chosen out of the body of the people without preference or distinction; which being agreed to, put an end for a season to all discontents on this head. About the same time Themistocles suggested the necessity of immediately fortifying the city, so as to prevent its being again destroyed whenever the Persians might deem it expedient to invade Greece. The Lacedæmonians disrelished this project exceedingly, and remonstrated against it, upon the hollow ground, that were Athens to be strongly fortified, and the Persians to become possessed of it, it might be impossible ever to dislodge them. The Athenians were not imposed on by this shallow pretence, which was soon changed into a peremptory command not to raise their walls higher; but, considering the great power of Sparta at that time, Themistocles advised the Athenians to temporize, and to assure the Spartan envoys that the work should not be proceeded with until by a special embassy satisfaction had been given to their allies. Being, at his own desire, named ambassador in conjunction with some other Athenians, Themistocles set out alone, telling the senate that it would be for the interest of the state to delay sending the other ambassadors as long as possible. Arrived at Sparta, he put off from time to time receiving an audience, on the pretence that his colleagues had not yet joined him; but in the meanwhile the walls of Athens were building with the utmost expedition, neither houses nor sepulchres being spared for materials, and men, women, children, strangers, citizens, and servants, labouring at the work without intermission. The truth, however, having at length oozed out, Themistocles and his colleagues, who had by this time arrived, were summoned before the ephori, who immediately began to exclaim against the Athenians on account of their breach of compact. But Themistocles stoutly

battle of Salamis. But ten months afterwards he commanded the Athenian forces at the battle of Plataea; so that his recall must have taken place between those two actions. (Herodotus, ix. 28.)

¹ Athens was occupied by Mardonius ten months after its occupation by Xerxes the preceding year, B. C. 480.

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denied the charge; his colleagues, he said, assured him of the contrary; at all events, it did not become a great state to give heed to vague rumours of this description; and if they had any doubts about the truth of his statement, the proper course would be to send deputies to inquire into the fact of the matter, whilst he should himself remain as a hostage to be answerable for the event. This plausible suggestion being agreed to, Themistocles engaged his associates to advise the Athenians to commit the Spartan ambassadors to safe custody until he should be released; after which he publicly avowed the whole transaction, acknowledged himself the author of the scheme, and told the Lacedæmonians that "all things are lawful for our country." The Spartans indeed were completely overreached; but seeing no remedy, they concealed their resentment, and sent Themistocles back to Athens in safety.

The following year, the last of the seventy-fifth Olympiad, Themistocles, observing the inconvenience of the port of Phalerum, formed the resolution of improving the Peiræus, and rendering it the principal harbour of Athens. The wily statesman did not at first think proper to mention publicly his scheme; but having signified to the people that he had something of importance to communicate, they appointed Xantippus and Aristides to examine his project and report thereupon. This they did accordingly; and having informed the people that what Themistocles proposed would be of the utmost advantage to the state, at the same time that it might easily be carried into effect, they were desired to lay the matter before the senate, who, coming unanimously into their measures, sanctioned the project; on which the work was set about and executed with as much expedition as the defences of the city, in order to prevent the possibility of opposition on the part of the Lacedæmonians. By these wise and prudent measures, undertaken and carried through with equal energy and address, the naval power of Athens was fixed on a sure basis, and the ascendancy in Grecian politics transferred from the Spartans to the Athenians.¹

Themistocles banished.

It now came to the turn of Themistocles to experience the ingratitude of his countrymen. His services had been too great ever to be repaid; so essential, in fact, that the treatment he received may perhaps be a sufficient excuse for modern patriots when they connect their own interest with the service of the country. Themistocles had confessedly saved the state from ruin by his advice; he had pre-eminently distinguished himself by his valour; he had rendered Athens, by his policy, superior to the other states of Greece; and he had entirely subverted the Lacedæmonian scheme of power. Yet notwithstanding all this, he was banished by the ostracism, without the shadow of crime being even alleged against him, except that he was hated by the Lacedæmonians, and that he had erected a temple near his own house, dedicated to Diana, the Giver of the best Counsel; intimating, with pardonable vanity, that he had himself given the best counsel for the safety both of Athens and of Greece, which was no more than the truth. The state he had exalted, the country he had saved, cast him forth, like an unclean thing, as if unworthy to breathe the common air on the soil of Greece, which he had delivered from the presence of the invader; and he was at length forced to seek shelter from the very monarch whose fleets he had defeated, whose ambition he had thwarted,

and whose glory the ascendancy of his genius had for ever tarnished. But more magnanimous and more enlightened than the inconstant race who insolently denominated him a barbarian, the king of Persia received his great enemy in the kindest and most gracious manner, endeavouring by his princely munificence to make him forget his misfortunes; and the conqueror of Salamis was never afterwards recalled, "because," as an old writer quaintly observes, "the Greeks had no occasion for his services."²

But the war with Persia was not yet discontinued, because the Greeks found their advantage in plundering and enriching themselves with the spoils of the Persians. For this reason, about the end of the seventy-seventh Olympiad, they equipped a navy, under pretence of relieving certain Greek cities in Asia, subject to the Persians, and gave the command of it to Cimon, the son of Miltiades by a daughter of the king of Thrace. Cimon had already tasted the justice and generosity of his countrymen, having been thrown into prison for his father's fine, from which he was released by Callias, whom his sister Elpinice had married on account of his great wealth, procured, it is said, by no very honourable means. But he nevertheless accepted of the command, and gained such immense booty in this expedition, that the Athenians were thereby enabled to lay the foundation of that longimural inclosure which united the port to the city; as also to adorn the Agora with palm-trees, and beautify the Academy with delightful walks and fountains. Soon after this expedition, the Persians having invaded the Chersonesus, and made themselves masters of it, with the assistance of the Thracians, Cimon was hastily sent against both. He had only four ships under his command; but with these he captured thirteen of the Persian galleys, and reduced the whole of the Chersonesus; after which he attacked the Thracians, who had made themselves masters of the gold mines situated between the rivers Nyssus and Strymon, and speedily obliged them to yield. But Cimon was as wise and politic as he was brave. Many of the Greek states, in virtue of a general tax established by Aristides with the view of providing a fund for the common defence, were bound to furnish men and galleys, as well as to pay for their support. But when they saw themselves exposed to danger from the Persians, most of them evinced an unwillingness to furnish their contingent of men. This exasperated the Athenian generals, who, finding them obstinate in their refusal, were for having immediate recourse to force; but Cimon overruled this proposal, permitted such as were desirous of staying at home to remain, and accepted a sum of money instead of a galley completely manned; by which means he inured the Athenians, whom he took on board his galleys, to hardship and discipline, whilst the allies, who remained at home, became enervated through idleness, and, from being confederates, dwindled into tributaries or slaves.

It was scarcely possible, however, for any person who had effectively served the state to escape banishment at Athens. Cimon had gained great wealth both to the state and to himself; but in his public character he had acted with unimpeached integrity, and as a private citizen he had dedicated his wealth to the most laudable purposes. He had demolished the inclosures about his grounds and gardens, permitting every one to enter and take what fruits they pleased; and he had kept open table, where both rich and

¹ For an account of the fortifications of the capital of Attica, the Long Walls, and the defences of Peiræus, Phalerum, and Munychia, see article ATHENS.

² A considerable period appears to have elapsed between the banishment of Themistocles by the ostracism, B. C. 471, and his flight into Persia. He withdrew to Argos, and resided there when the treason of Pausanias was discovered: as is manifest from Diodorus, xi. 55; Plutarch, *Themistocles*, c. 23; and Thucydides, i. 135. It would indeed seem that the plans of Pausanias had been communicated to him during his exile; a proof that he had been living in a state of banishment a considerable period before he passed over into Persia, and sought the protection of his former enemy.

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War with Sparta. The Athenian power had now risen to such a height that all the other states of Peloponnesus looked upon the republic with a jealous eye, and were continually watching for opportunities of making war upon it when engaged in troublesome affairs, or hard pressed by other enemies. These attempts, however, so far from lessening, generally contributed to increase the power of the Athenians. But in the year B. C. 458 the republic entered into a war with Sparta, which eventually proved nearly as fatal to the state as to the city. For this war no recent provocation had been given on the part of the Spartans. They had indeed sent a considerable army to assist the Dorians against the Phocians; but the Athenians had no interest in the contest, and only sought an occasion to revenge former quarrels. Having therefore engaged the Argives and Thessalians as confederates, they posted themselves on the isthmus, so that the Spartan army could not return without encountering them. The Athenians and their confederates amounted to 14,000, and the Spartans to 11,500 men. The Lacedæmonian general, however, unwilling to hazard a battle, turned aside to Tanagra, a city of Bœotia, where some of the Athenians who were favourable to aristocracy entered into a correspondence with him. But before their designs were ripe for execution, the Athenian army marched with great expedition to Tanagra, and instantly made arrangements for the attack. They were however defeated with great loss, as they justly deserved to be, considering the unprovoked nature of the aggression. Another engagement soon followed, in which both armies suffered so much that they were glad to conclude a short truce, that each might have time to recruit their shattered forces. But the scale of fortune soon turned in favour of the Athenians. The Thebans, who had been deprived of the command of Bœotia on account of their having sided with Xerxes, were now restored to it by the Lacedæmonians.

At this the Athenians were so greatly displeased that they sent an army under Myronides the son of Callias into Bœotia to overturn all that had been done. That general was encountered by the Thebans and their allies, who composed a numerous and well-disciplined army; but although the Athenian army was but a handful in comparison of that of their enemies, Myronides gained a victory over the allies, which, in a purely military point of view, may perhaps be considered as more glorious than either that of Marathon or of Plataea. In these battles they had fought against the effeminate and ill-disciplined troops of Persia; but now they encountered and defeated a superior army composed of the bravest Greeks. After this victory Myronides marched to Tanagra, which he took by storm, and afterwards razed to the ground. He then plundered Bœotia; defeated another army which the Bœotians had drawn together to oppose him; next fell upon the Locrians; and having penetrated into Thessaly, chastised the inhabitants of that country for having revolted from the Athenians; after which he returned to Athens laden alike with riches and with glory.

About this time Cimon was recalled from banishment by the will of the sovereign people, and soon after fell to his old employment of plundering the Persians; having nothing less in view, according to Plutarch, than the conquest and subjugation of the whole Persian empire. But, however this may be, the Great King, finding he could have no rest whilst he continued in a state of hostility with the Athenians, sent instructions to his generals Artabazus and Megabizus, to conclude, if possible, a treaty of peace; which, after much discussion, was at length effected upon the following conditions: 1. That the Greek cities in Asia should be free, and governed by their own laws; 2. that the Persians should send no army within three days' journey of the sea; 3. that no Persian ship of war should sail between Thessalis in Pamphylia and Cyrene in Lycia. Whilst this treaty was pending Cimon died, B. C. 449, but whether of sickness or of a wound which he had received in battle remains unknown.

One thing, however, is certain, that after the death of this remarkable personage, the Athenian affairs began to fall into confusion. It was now the misfortune of the republic to be alike hated by her enemies and by her allies; and hence the latter missed no opportunity of throwing off their allegiance, when they thought they could do so with impunity. The Megarensians, for instance, who had long been under the protection of Athens, thought proper to disclaim all dependence on their ancient protectrix, and to have recourse to Sparta, with which they entered into a strict alliance, offensive and defensive. Exasperated at this proceeding, and determined to punish the ingratitude of their former allies, the Athenians ravaged the country of the Megarensians; a step which soon brought on a renewal of the Lacedæmonian war, which had been suspended rather than terminated. But Pericles procured the return of the first Lacedæmonian army without bloodshed, by bribing Chandrides, the young king of Sparta's tutor; and the Lacedæmonians, finding it was not for their interest to carry on the war, concluded a truce or pacification with the Athenians for the period of thirty years.¹

Six years after the conclusion of the peace between Athens and Sparta, a war broke out between the Samians of Samos and Milesians, about an insignificant town situated under Mount Mycale in Ionia. In this war the Athenians took part, for what reason we are not informed; and the island of Samos was reduced by Pericles, who established there a democracy, and left an Athenian garrison. He was no

¹ On the subject of the thirty years' truce, concluded B. C. 445, the reader may consult and compare Andocid. *de Pace*, p. 14, 24; Æschin. *Fals. Leg.* p. 23, 51. It was about this time that Pericles began to assume the sole direction of affairs.

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sooner gone, however, than the Samians, disliking their new form of government, rose in arms and expelled the garrison; but Pericles quickly returning, besieged and took their city, demolished their walls, and fined them in the whole expense of the war; part of which he obliged them to pay down, and took hostages for the remainder.¹

Corcyrian war.

This insignificant contest was almost immediately followed by a war between the Corcyrians and Corinthians, which arose out of the following circumstances. An intestine broil breaking out in the little territory of Epidamnus, a town of Macedonia, founded by the Corcyrians, one party applied for aid to the Illyrians, and the other to the Corcyrians. But the latter having neglected the matter, Corinth was appealed to, as the Corcyrians were originally a colony from that place; and the Corinthians, partly out of pity for the Epidamnians, partly from dislike to the Corcyrians, dispatched a considerable fleet to the assistance of the former, by which means the party which had appealed to Corinth gained the ascendancy. This being resented by the Corcyrians, they sent a fleet to Epidamnus to support the exiles; but although this fleet began to act offensively on its entering the port, the chief commanders had instructions to propose terms of accommodation. To these, however, the Corinthians refused to accede; and next year the Corcyrians defeated the Corinthians and their allies at sea, took Epidamnus by storm, and wasted the territories of the allies of the Corinthians. The latter, therefore, began to make great preparations for carrying on the war, and pressed their allies to imitate their example, that they might be in a condition to retrieve the honour they had lost, and to humble the ungrateful colony, which had thus insulted the metropolitan city.

When the Corcyrians became acquainted with these proceedings, they dispatched envoys to Athens to sue for aid; and these were quickly followed by others from Corinth on the same errand. At first the Athenians inclined to favour the Corinthians, but with their usual fickleness they soon changed their minds and took part with the Corcyrians; contenting themselves, however, with entering into a defensive alliance with that little state, and furnishing the Corcyrians with ten galleys, under the command of Lacedæmonius the son of Cimon. But this determination did not retard the preparations of the Corinthians, who, as soon as the season permitted, sailed for the coast of Corcyra with a fleet of 150 ships, under the command of Xenocles, assisted by four other Corinthian admirals; each squadron of their allies being commanded by an admiral of its own. The Corcyrian and Athenian fleet amounted to 120 sail, but the Athenians had orders to give as little assistance as possible. A brisk action ensued, in which the Corcyrian right wing broke the left of the Corinthian fleet, and drove some of the ships on shore; whilst the Corinthian ships in the right wing defeated the Corcyrian ships opposed to them. Next day preparations were made on both sides for renewing the battle; but twenty ships arriving opportunely from Athens to the assistance of the Corcyrians, turned the scale against the Corinthians, who therefore declined the combat.

As soon as the Corcyrian war broke out, the Athenians sent orders to the citizens of Potidæa to demolish part of their wall, to send back the magistrates they had received from Corinth, and to give hostages for their own behaviour. The Potidæans, however, refused to comply with this demand, upon which the Athenians dispatched a considerable fleet against them, under the command of Callias, a man celebrated for his courage; whilst the Corinthians, on

the other hand, sent one Aristæus, with a considerable body of troops, to the assistance of the city. An engagement ensued, in which the Athenians were victorious, but their brave general fell in the action. Phormio, who succeeded to the command on the death of Callias, then invested the city in form, and blockaded its harbour with his fleet; but the Potidæans, dreading the vengeance of the Athenians, made a most obstinate defence, at the same time warmly soliciting the Corinthians to perform their promises, and to engage the rest of the states of Peloponnesus to take part in their quarrel.

Meanwhile the Lacedæmonians having heard the complaints of the Corinthians and other small states of Greece against the Athenians, sent ambassadors to Athens to demand reparation for the injuries done to these states, and, in the event of refusal, to denounce war. The terms demanded were, first, that all Athenians who were allied to the family of Megacles should be expelled from Attica; secondly, that the siege of Potidæa should be raised; thirdly, that the inhabitants of Ægina should be left free; and, lastly, that a decree prohibiting the Megarensians from resorting to the ports and markets of Athens should be revoked, and all the Grecian states under the dominion of Athens set at liberty.

By the persuasion of Pericles, however, these degrading terms were rejected; and while the right arbitrarily claimed by the commonwealth of Sparta to interfere in the concerns of the other Greek states, in the character of a lord-paramount, was peremptorily denied, an accommodation was proposed upon the fair principles of equality and reciprocity. In recommending the measure which he suggested for the adoption of his countrymen, this celebrated statesman argued, that whatever the Lacedæmonians might pretend as to the complaints of the allies, the true ground of their resentment was the prosperity of the Athenian republic, which they had always hated, and now sought an opportunity of humbling; and that it must be owing to the Athenians themselves if this design succeeded, because, for many reasons, Athens was better able to engage in a long and expensive war than the Peloponnesians. He then laid before the people an exact account of their circumstances;—reminding them that the treasure brought from Delos amounted to no less than ten thousand talents; that, although four thousand of these had been expended on the magnificence of their citadel, six thousand still remained in their coffers; that they were also entitled to the subsidies payable by the confederate states; that the statues of their gods, the spoils of the Persians, and other valuable property, were worth immense sums; that many private individuals had amassed vast fortunes; that, considering the extent of their trade and commerce, they might calculate upon a certain annual increase of wealth; that they had on foot an army consisting of 12,000 men, besides 17,000 in their colonies and garrisons; that their fleet amounted to 300 sail; and, finally, that the Peloponnesians, with whom they might be called to contend, had none of these advantages, and, as compared with the Athenians, were nearly destitute of all those resources which constitute the sinews of war. For these reasons he proposed, as at once the most consistent and most equitable satisfaction that could be given, to reverse the decree against Megara, provided the Lacedæmonians agreed to accede to the principle of reciprocity in favour of the Athenians and their allies; to consent to leave all those states free which were acknowledged as such at the conclusion of the last peace with Sparta, provided the latter state also agreed to give freedom to all the states which

¹ Thucydides, i. 117.

Attica. were under their dominion; and, finally, to submit to arbitration all disputes which might in future arise between the parties to this arrangement. He concluded by advising them to hazard a war in case these terms were rejected; telling them, that they should not think they ran that hazard for a trifle, or retain a scruple in their minds as if a small consideration moved them to it, because on this matter depended their safety, and the reputation of their constancy and resolution. If they yielded in this, the next demand of the Lacedæmonians would be still more extravagant; for having once discovered that the Athenians were to be acted upon by fear, they would thence conclude that nothing could be denied them, whereas a stout resistance in the present case would teach them to treat Athens in future upon terms of reciprocity.

Peloponnesian war.

The firm attitude which Athens assumed on this occasion, under the guidance of her most illustrious statesman, may be considered as the origin of the Peloponnesian war, which makes so prominent a figure in ancient history. The immediate preliminary to general hostilities, however, was an attempt of the Thebans to surprise Plataea. With this view they sent Eurymachus with three hundred men to assist those of the Plataeans whom they had drawn over to their interest, in making themselves masters of the place. But although the design succeeded very well at first,—the Plataeans, who had promised to open the gates, keeping their words exactly, so that they instantly obtained possession of the city,—yet the other party, perceiving the smallness of the number they had to contend with, unanimously rose upon them, killed a great many, and forced the remainder to surrender themselves prisoners of war. The Thebans sent a reinforcement to assist their countrymen, but it arrived too late to be of any service, and the whole were ultimately obliged to withdraw. As soon as the Athenians were apprized of this attempt, they caused all the Bœotians in their territory to be arrested; and when they understood how their allies had delivered themselves, they immediately dispatched a considerable convoy of provisions to Plataea, together with a numerous body of troops for the purpose of escorting the wives and children of the inhabitants to Athens. This attempt leaving no doubt that all hopes of accommodation were at an end, both parties began to prepare in good earnest for war. Most of the Grecian states inclined to favour the Spartans, partly because the latter assumed the character of deliverers of Greece, and partly also because many of the states either had been, or feared they would be, oppressed by the Athenians. Accordingly, the whole of the Peloponnesians except the Argives and part of the Achæans made common cause with the Spartans; whilst, on the continent of Greece, the Megarensians, Phocians, Locrians, Bœotians, Ambraclots, Leucadians, and Anactorians, declared for the Athenians; as also did the Chians, Lesbians, Plataeans, Messenians, Acarnanians, Corcyrians, Zacynthians, Carians, Dorians, Thracians, and all the Cyclades, excepting Melos and Thera, together with Eubœa and Samos.

First year. The Peloponnesian war commenced in the year B. C. 431. The Lacedæmonian army, consisting of no less than 60,000 men, assembled on the isthmus, and, after a vain attempt at negotiation, the campaign opened. The Lacedæmonian army was commanded by Archidamus, king of Sparta; that of the Athenians by Pericles, with nine

generals under him. Soon after the opening of the campaign, the Spartan force entered Attica and committed horrible ravages; Pericles having no force capable of opposing it, and steadily refusing to engage on disadvantageous terms, notwithstanding prodigious clamours were in consequence raised against him by his countrymen. The invaders, however, had no great reason to boast of the advantages they had gained; for an Athenian fleet ravaged the coasts of Peloponnesus, whilst another infested the Locrians, expelled the inhabitants of Ægina, and repopled the island from Athens and Attica. Cephalenia, and some towns in Acarnania and Leucas which had declared for the Lacedæmonians, were also reduced; and in the autumn, when the Peloponnesians had retired, Pericles entered the Megarensian territory, which he laid waste with fire and sword, in revenge for the devastation committed in Attica.

Attica.

But the spring of the second year proved signally disastrous to Athens; for a dreadful plague carried off great numbers of the citizens, whilst the Peloponnesians, under Archidamus, wasted every thing abroad. In the midst of all these calamities, however, the firmness of Pericles remained unshaken; and he would suffer none of his countrymen to stir from the city, either to escape the plague, which committed horrible ravages within the walls, or to assail the enemy, who desolated the country without.¹ He meditated deeper game, namely, an inroad into the enemy's territory, which in fact had been left completely uncovered by the attack upon Attica. With this view he caused a large fleet to be equipped, on board which he embarked 4000 foot and 300 horse, and immediately set sail for Epidaurus. This diversion produced the desired effect, in compelling the enemy to withdraw from Attica; but in other respects the expedition failed on account of the plague, which committed so great havoc among his men, that Pericles brought back to Athens only 1500 of the 4300 composing the expedition. By this disaster the Athenians were thrown into utter despair, and immediately sued for peace; but the Spartans refusing to accede to any terms of accommodation, their despair gave place to fury against their great statesman and commander, whom (as the mob must always in such cases have a victim) they basely dismissed from their service, and amerced in a heavy fine. And, as if this had not been enough, at the same time that Pericles experienced the ingratitude of his country, the plague carried off his children and nearly the whole of his kindred, leaving him almost alone in the world, childless and forsaken. This accumulation of misfortunes preyed deeply on his spirits and overwhelmed him with melancholy, in consequence of which he secluded himself for a time entirely from public view. But through the persuasion of Alcibiades and other friends, he was at length induced to show himself to the people; who, ever inconstant, and often as prompt to pardon as to condemn, received him with acclamations of joy, and declared him the only man qualified to save the state in its present exigency. The first use Pericles made of his recovered popularity was to procure the repeal of the iniquitous law which he had himself caused to be enacted, whereby all Athenians of the half blood were disfranchised of their natural liberty, and reduced to a state of helotism; a measure which was not altogether disinterested on his part, as he was thereby enabled to enrol in the list of citizens his

¹ In this campaign the Peloponnesians remained forty days in Attica, burning and destroying without, while the pestilence was raging within the city, and while the Athenians seemed abandoned to utter despair. For an account of this memorable plague see Thucydides, ii. 47, whose description has been often imitated, but never equalled, far less surpassed. That which approaches nearest to it in horrible truth and picturesqueness of delineation is the description of the plague in Egypt, and also in the prison of the Seraglio at Constantinople, contained in the novel entitled *Anastasius, or Memoirs of a Modern Greek*; a work which displays greater talents, and gives a more vivid and faithful picture of society and manners in the countries of the Levant, than all the books which have yet been written on the subject.

Attica. only remaining son by a Milesian mother, whom the operation of the law in question had of course bastardized. But this was destined to be one of the last public acts of the great Athenian statesman and patriot.

Third year. The third year of the Peloponnesian war was chiefly remarkable for the death of Pericles, who at length fell a victim to the plague, which had already desolated his house, but who left behind him a name that will never die.¹ Plataea was also besieged by Archidamus, but without success; for although the greater part of it had been set on fire, the Plataeans resolved to submit to every extremity rather than abandon the Athenian cause. In the end, therefore, the king of Sparta was obliged to convert the siege into a blockade, and to return to Peloponnesus.

Fourth year. In the following summer the Peloponnesians under Archidamus again invaded Attica, wasting every thing with fire and sword; and at the same time the whole island of Lesbos, except the district of Methymna, revolted against the Athenians. In the meanwhile Plataea was strictly blockaded, and its inhabitants being reduced to the greatest extremity from want of provisions, the garrison came to the resolution of forcing a passage through the enemy's lines. When the moment arrived, however, for carrying this design into execution, many of them became intimidated; but the greater number persisting in their resolution, succeeded in their gallant attempt, and above two hundred reached Athens in safety.

Fifth year. In the beginning of the fifth year the Peloponnesians sent forty ships to the relief of Mitylene, which the Athenians had invested after the revolt of Lesbos; but this effort proved unavailing, since the place had surrendered before the fleet could come to its assistance. Paches, the Athenian commander, then drove off the Peloponnesian fleet; and returning to Lesbos, sent the Lacedæmonian minister, whom he found in Mitylene, together with a deputation, to Athens. On their arrival the Lacedæmonian was immediately put to death; and in a general assembly of the people, it was resolved that all the Mitylenians who had attained to manhood should also be put to death, and the women and children sold as slaves. But the next day this cruel decree was revoked, and a galley dispatched to countermand the sanguinary order; which, however, arrived before the reversal, owing to the slow sailing of the vessel sent off with the latter. But Paches, being a man of great humanity, had fortunately taken a day to consider the orders he had received; and the last-mentioned galley arriving during this interval, only about a thousand of the principal insurgents were put to death. The walls of the city were however demolished, their ships taken away, and their lands divided among the Athenians, who let them again to their former proprietors at exorbitant rents. About this time also the Plataeans who had failed in the attempt to break through the enemy's lines surrendered at discretion, and were cruelly put to death by the Lacedæmonians, who sold their women as slaves. The city was soon after razed by the Thebans, who left only an inn to show where it stood; but the fame of Plataea induced Alexander the Great afterwards to rebuild it on a more extensive scale.

In this year also happened the famous sedition of Corcyra, proverbial for the horrors with which it was accompanied. We have already seen that the dispute between the Corcyrians and Corinthians was mainly instrumental in bringing on the Peloponnesian war, one of the most protracted and sanguinary contests of ancient times. At the commencement of this struggle a great number of Corcyrians were, it seems, carried as prisoners into Peloponnesus, where the chief of them were well treated, and the remainder sold as slaves. The motive of this conduct on the part of the Corinthians was a design they had formed of engaging these Corcyrians to influence their countrymen to join the Corinthians and their allies. With this view the latter treated them with all imaginable lenity and tenderness, endeavouring to instil into their minds a hatred of democratic government; after which they were informed that they might obtain their liberty upon condition of exerting their influence at home in favour of the allies, and to the prejudice of Athens. This the Corcyrians readily promised and endeavoured to perform; and at first the partisans of aristocracy so far prevailed, that, assisted by a Peloponnesian fleet, they murdered such of the opposite party as fell into their hands. But the Athenians having dispatched first one fleet and then another to the assistance of their friends, the Peloponnesians were forced to withdraw, leaving the aristocrats at the mercy of the democratic party; who, having thus gained the ascendancy, literally exterminated their antagonists with circumstances of horrible atrocity. Nor was this all. For, the example once set, the several states of Greece in their turn experienced similar commotions, which were invariably fermented by agents of Sparta or of Athens; the former endeavouring to establish an aristocratic and the latter a democratic form of government, wherever their influence happened to prevail.

While the Athenians were thus engaged in a contest Sicilian in which they were already overmatched, they foolishly rushed into a new one, which in the end proved more disastrous than any in which they had yet embarked. The inhabitants of Sicily were, it seems, divided into two factions; the one called the Doric, at the head of which was Syracuse; the other the Ionic, at the head of which was Leontium. But the Ionic faction finding itself too weak to contend with its rival without foreign aid, sent Gorgias of Leontium, a celebrated orator, sophist, and rhetorician, to Athens to apply for assistance; and he by his fine speeches so captivated the giddy and inconstant multitude, the *Μεγα Θρῆμμα*, or Great Beast (as the populace were sometimes contemptuously styled in private, by those who did not scruple to pander to their worst passions in public), that they rushed headlong into a war which they were unable to maintain while engaged in a death-struggle with nearly all the states of the Peloponnesus. Accordingly, bewrayed by the wily sophist,² and probably enticed by the hope of effecting the conquest of Sicily, they dispatched a fleet to the assistance of the Leontines, under the command of Lachetes and Chabrias; and this had no sooner sailed than another destined for the same service was begun to be fitted out. In the mean time the plague

Attica.
Sedition of
Corcyra.

¹ Corsini (*Fast. Att.* tom. ii. p. 60) says, "Pericles excessit Ol. 87. 4 octogenario major, quippe qui Plutarcho teste 55 annis remp. administraverit." This is inaccurate, and proceeds on a misapprehension of Plutarch (*Pericl.* c. 16), who merely says that Pericles was engaged in public affairs forty years, and performed certain functions during fifteen; but the fifteen are evidently included in the forty. Accordingly, Cicero (*Orat.* iii. 34) says, "Quadraginta annos præfuit Athenis;" and from other authorities we learn that he began to appear in public affairs about the year B. C. 469, and to have the sole direction about the year B. C. 444; so that he could not have exceeded fourscore at the time of his death, which took place in B. C. 429.

² Diodorus, xii. 53. See also Pausanias, vi. 17, 5, and Philostratus in *Vit. Gorg.* This celebrated artist in the dangerous craft of making the worse appear the better reason, would seem to have been a singular specimen of "health and longevity;" for, according to Philostratus, *λεγίσται δὲ Γοργίας ἐς οὐτὼν καὶ ἑκατὸν ἔλασαι ἐστὶν*; but the sounder opinion seems to be, that he was born about B. C. 485, and died soon after B. C. 380, at the age of 105 or 106. He was in reputation as a sophist and rhetorician for nearly fourscore years. (*Fasti Hellenici*, p. 63.)

Attica. continued its ravages to such an extent that in the course of this year four thousand citizens, and a much larger number of the lower class of people, fell victims to its fury.

Sixth and seventh years. The sixth year of the Peloponnesian war was not remarkable for any great exploit. Agis, the son of Archidamus, king of Sparta, assembled an army in order to invade Attica; but he was prevented doing so by earthquakes, which shook almost every part of Greece, and produced general consternation. The next year, however, he entered Attica with his army; whilst the Athenians, on their part, sent a fleet, under the command of Demosthenes, to infest the coasts of Peloponnesus. As this fleet passed the coast of Laconia, the commander observed that the promontory of Pylos, which was joined to the continent by a narrow neck of land, had before it an island about two miles in circumference, which, though barren in itself, nevertheless contained an excellent harbour, sheltered from all winds either by the headland or isle, and capable of admitting the most numerous fleets; circumstances which led him to conclude that a garrison left here would alarm the Peloponnesians, and induce them to think rather of protecting their own country than of invading that of their neighbours. Accordingly, having raised a strong fortification, he established himself in the post, reserving five ships of war for its defence; and ordered the rest of the fleet to proceed to its intended destination. On the news of this event the Peloponnesian army immediately returned to besiege Pylos, and soon made themselves masters of the harbour, as well as of the island of Sphacteria, which was taken by a chosen body of Spartans. They then made a vigorous attack upon the fort, hoping to carry it before succours could arrive; but Demosthenes and his garrison made an obstinate defence; and an Athenian fleet arriving in the interval, relieved the besieged from all apprehensions on account of the superior force of the enemy. Battle was immediately offered; but as the Peloponnesian fleet declined the challenge, the Athenians sailed boldly into the harbour, and sunk or destroyed most of the enemy's ships, after which they besieged the Spartans in Sphacteria. Alarmed at finding the war carried into their own territory, the Peloponnesians now began to treat with their enemies; and whilst the negotiations were carrying on at Athens, a cessation of hostilities was agreed to, upon the condition that the Peloponnesians should in the mean time deliver up all their ships, but that in the event of the treaty not taking effect, these should be immediately restored. In as far as regards the negotiations, the Athenians, having heard the propositions of the Spartan plenipotentiaries, were at first strongly inclined to put an end to this ruinous and destructive war, all the evils of which had been so greatly aggravated by the dreadful pestilence which at the same time ravaged the city of Athens and part of the territory of Attica. But the orator Cleon, a warm and headstrong man, persuaded his countrymen to insist on the most unreasonable terms; and as the confederates were by no means so far reduced as to suffer the Athenians *pacis imponere morem*, to dictate terms of peace, the plenipotentiaries withdrew, and by doing so, of course put an end to the armistice. The Peloponnesians then demanded the restoration of their vessels, conformably to the stipulation above mentioned; but the Athenians refused to deliver them up, on the miserable and dishonest pretence that the former had violated the truce. Hostilities, therefore, were immediately recommenced on both sides; and the Lacedæmonians attacked the Athenians

at Pylos, while the latter attacked the Spartans at Sphacteria. But the Lacedæmonians, though only a handful of men, and under every imaginable discouragement, defended themselves with so much bravery that the siege proceeded very slowly; and the people of Athens becoming uneasy at its duration, began to wish they had embraced the offers of the Spartans, and to rail vehemently against Cleon, who had been primarily instrumental in occasioning their rejection. To excuse himself, however, the orator affirmed it would be an easy matter for the general of the forces which they were then sending to attack the Spartans in the isle, and reduce them at once. Nicias, who had just been appointed to the command, replied that if Cleon believed he could perform such wonders, he would do well to repair to the scene of action in person. The orator, compelled to sustain his part, rejoined without hesitation that he was ready to go with all his heart; upon which Nicias caught him at his word, and declared that he had relinquished his command. Startled at this renunciation, the speech-maker protested that he was no general; but Nicias tauntingly assured him that he might some day become one; and the people, amused with the controversy, held the orator to his word. Cleon then advancing, told them he was so little afraid of the enemy, that, with a very inconsiderable force, he would undertake, in conjunction with that already at Pylos, to bring to Athens in twenty days the Spartans who had given them so much trouble. The people laughed at this apparent gasconade; but having furnished him with the troops he desired, the orator, to the infinite surprise of every one, brought the Spartans prisoners to Athens within the time he had specified.¹

In the eighth year of the war Nicias reduced the island of Cythera on the coast of Laconia, and Thyraea, a frontier territory, which had been given to the Æginetans when expelled from their own country by the Athenians. In Sicily, Hermocrates of Syracuse, having persuaded the inhabitants of the island to adjust their differences without foreign interference, the Athenian generals returned home; a step which so greatly displeased their countrymen that two of them were banished, and the third was sentenced to pay a heavy fine. The Athenians, under the conduct of Hippocrates and Demosthenes, next laid siege to Megara; but Brasidas, a Spartan general, coming to its relief, a battle ensued, which, though indecisive in its result, gave the Lacedæmonian faction an ascendancy in Megara, and forced many who had favoured the Athenians to withdraw. In Bœotia some commotions were raised in favour of the Athenians; but their generals Hippocrates and Demosthenes being defeated by the Lacedæmonian party, all hopes ceased of the Athenian power being established in this district of Greece.²

In the ninth year the Spartans made new proposals of peace, which the Athenians were now more inclined to accept than formerly; so, finding their affairs much unsettled by the loss of Amphipolis, which had been reduced by Brasidas, a truce for a year was agreed on, while negotiations were immediately opened for restoring a general peace. But this pacific scheme was soon overthrown by a misunderstanding, arising out of an occurrence purely accidental, and the war was in consequence renewed.

The following year commenced with an attempt by Nicias upon Potidæa; but this having failed, the Athenians began to recover some courage; and the truce expiring on the day of the Pythian games, Cleon advised the Athenians to send an army under his own command

¹ Thucydides, iv. 39.

² Alcibiades seems to have already begun to take part in public affairs. See a passage in the Wasps of Aristophanes, 44, where his manner of speaking is ridiculed. At this time he was about twenty-four years of age.

Attica. into Thrace. They agreed to this proposal, and immediately fitted out a force, consisting of 1200 foot and 300 horse, all Athenian citizens, embarked on board thirty galleys, of which the orator took the command. Brasidas was inferior in numbers to his opponent; but, observing that the Athenian commander was careless, and neglectful of discipline, the Spartan suddenly attacked him, and routed his army with the loss of half its numbers, while that of the assailants amounted to only seven killed and a few wounded. In this encounter, which appears to have been a complete surprise, the commanders on both sides were slain; and although the Athenians might well spare their orator-general, whom impudence and accident had invested with a military command, the death of their brave leader was a serious loss to the Spartans, who, in fact, lamented him more than the Athenians did the loss of the battle. In consequence of this event, however, the latter were now much more disposed than formerly to hearken to terms of accommodation. Amongst the Spartans, too, there was a party, at the head of whom was Plistonax, their king, who earnestly wished for peace; and as Nicias laboured no less assiduously at Athens to bring about this desirable event, a peace was at last concluded between the two nations for the period of fifty years.¹ The conditions were, a restitution of places and prisoners on both sides; with the exception of Nisæa, which was to remain in the hands of the Athenians, who had taken it from the Megarensians, and of Plataea, which was to continue in possession of the Thebans, who could not possibly give it up without uncovering the whole of their territory. The Bœotians, Corinthians, and Megarensians, refused to be included in this peace; but the rest of the allies acquiesced; and being accordingly ratified, it received the name of the Nician pacification, from that of the individual who had been mainly instrumental in restoring the blessing of peace to his country.

New mis-
under-
standings.

But although peace had been nominally established, tranquillity was far from being restored. Dissatisfied with the treaty on various grounds, several states of the Peloponnesus, headed by Argos, immediately commenced organizing a new confederacy; even the Lacedæmonians found it impossible to fulfil exactly the stipulations of the agreement; and the town of Amphipolis in particular peremptorily refused to return under the government of Athens; for which reason the Athenians also refused to evacuate Pylos. In the course of the winter fresh negotiations were opened, but nothing definite was agreed upon, and the time passed in mutual complaints and recriminations. At Athens, in particular, the flame of discontent was artfully fanned by Alcibiades, who now began to rival Nicias in public favour, and who, perceiving that the Lacedæmonians paid their court principally to his rival, took every opportunity of incensing his countrymen against that nation. On the other hand Nicias, whose reputation was concerned in maintaining the treaty inviolate, used his utmost endeavours to bring about a reconciliation, and even undertook a journey to Sparta, in the hope of effecting an accommodation; but, most unhappily, the artifices of Alcibiades, added to the turbulent and haughty disposition of both nations, rendered all his efforts unavailing, and at length satisfied him that a renewal of the war was inevitable. If the intrigues of this remarkable man, however, were mainly instrumental in bringing about a rupture, it cannot be denied that he took the most prudent methods for insuring the safety of his country. With this view he entered into a league with the Argives for the long term of a hundred years; he then marched into the

territories of that state at the head of a considerable force; and he exerted all his influence, both at Argos and at Patræ, to persuade the people to connect their cities with the sea by means of walls, in order to facilitate the landing of succour, when it might be necessary, by the Athenians. But, though vigorous preparations were now made for a renewal of the war, nothing of any consequence was undertaken this year; if we except an attempt by the Argives to make themselves masters of Epidaurus, which was, however, defeated by the Lacedæmonians throwing a strong garrison into the place.

Attica.

The next being the fourteenth year of the Pelopon-
nesian war, a Spartan army, under the command of Agis, entered the territory of Argos; but just as battle was on the eve of commencing, a truce was suddenly concluded between two of the Argive generals and the king of Sparta. But it so happened that neither party felt satisfied with this proceeding, and both the king and the generals were very ill received by their respective fellow-citizens. Accordingly, on the arrival of some fresh troops from Athens, the Argives immediately broke the truce; and a battle ensuing soon afterwards, the allied army was defeated with great slaughter by Agis, who thus achieved a victory on the very spot which was afterwards destined to acquire additional celebrity as the scene of one of the most disastrous defeats which the Spartan arms ever experienced. In the winter a strong party in Argos joined the Lacedæmonians; in consequence of which that city renounced her alliance with Athens, and concluded peace with Sparta for the period of half a century. Further, in compliment to their new allies, the Argives abolished democracy in their city, substituting an aristocracy in its stead; and they also assisted the Lacedæmonians in forcing the Sicyonians to adopt a similar form of government. Notwithstanding all this, however, the Argives, with a levity natural to the Greeks, renounced their alliance with Sparta the following year; abolished aristocracy, drove the Lacedæmonians out of the city, and renewed their league with Athens. On the other hand the Athenians, convinced of the bad faith of Perdiccas, king of Macedonia, abjured his alliance and declared war against him; preferring, as they said, an open enemy to a treacherous friend. And as Argos was still distracted by adverse factions, Alcibiades in the course of the ensuing year terminated all disputes between them by the expulsion of the Spartan party. He then sailed for the island of Melos, which had shown the greatest inveteracy against his countrymen, in order to punish the inhabitants for repeated acts of wanton hostility; but perceiving that the reduction of the island would be a work of time, he left a considerable body of forces there, and returned to Athens. In his absence, however, the capital of Melos surrendered at discretion, and the inhabitants were treated with the utmost severity; all the men capable of bearing arms being slaughtered, and the women and children carried into captivity.

In the beginning of the seventeenth year, Nicias was appointed commander-in-chief of an expedition destined to act against the Syracusans, with Alcibiades and Lamachus as colleagues. But whilst the necessary preparations were being made, Athens was thrown into terrible confusion by the defacing of the Hermæ or statues of Mercury, of which there was a great number in the city; an outrage equally wanton in itself, and appalling to the people of Athens, who revered these statues both as monuments of art and as symbols of religion. Great efforts were in consequence made to discover the perpetrators of

Loss of the
Athenian
army in
Sicily.

¹ Thucydides, v. 18, 19, 20.

Attica. this sacrilege; but although ample rewards were offered, no disclosure was then made. At last, from some cause unexplained, suspicion fell upon Alcibiades, who in consequence received orders to return immediately from Sicily in order to take his trial for this alleged crime. But he knew the temper of his countrymen too well to trust himself to their mercy; wherefore, instead of returning to Athens, he fled to Sparta, where he met with a gracious reception; whilst the Athenians were severely punished by the loss of their army, generals, and fleet, in Sicily; a disaster which the superior abilities of Alcibiades would in all probability have prevented.

Intrigues
of Alcibi-
ades.

The nineteenth and twentieth years of the war were spent by the Athenians in equipping a new fleet in order to repair their losses; but Alcibiades hurt their interests greatly by persuading Tissaphernes the Persian to league with the Spartans against them, and at the same time stirring up several of the Ionian states to revolt against what he described as the mob government of Athens. Equally restless and profligate, however, this celebrated Athenian had scarcely established himself amongst his new allies when he contrived, by means of a handsome person and an insinuating address, to debauch the wife of Agis the Lacedæmonian commander; and as the latter strongly resented the affront which had been put upon him, the Athenian seducer was obliged to quit Sparta and pass over into Persia. Here, however, he met with a favourable reception from Tissaphernes, who profited much by his advice, which, in fact, was equally shrewd and insidious. "Let the Greeks," said he to the Persian general, "exhaust themselves by their mutual wars; foment discord among them, which you will always find comparatively an easy task; take care never to let one state be totally destroyed, but always to support the weaker party against the more powerful;—follow this policy for a time, and the Greeks will themselves spare you the trouble of conquering them. By their incessant contests they will so weaken themselves that their country will become the prey of the first invader."

Abolition
of demo-
cracy.

As may easily be supposed, Tissaphernes readily acquiesced in these counsels; upon which Alcibiades wrote privately to some of the officers in the Athenian army at Samos, informing them that he had been treating with the Persians in behalf of his countrymen, but that he did not choose to return till the democracy should be abolished; adding, that the Persian king disliked a democracy, but would immediately assist them if that was abolished, and an oligarchy established in its stead. On the arrival of Pisander and other deputies from the army with the proposals of Alcibiades, the Athenians without hesitation resolved to overturn the democratical form of government which they had all along so strenuously defended; in consequence of which Pisander and the deputies received directions to return to Alcibiades, in order to ascertain precisely on what terms the king of Persia was disposed to enter into an alliance with them. But perceiving that Tissaphernes was by no means inclined to assist the Athenians, on account of their recent successes, Alcibiades artfully set up such extravagant demands in the king of Persia's name, that the Athenians of themselves broke off the treaty, and thus enabled him to outwit both parties without offending either. But notwithstanding the failure of the negotiations with Tissaphernes, the democratical form of government was abolished, first in the cities subject to Athens, and afterwards in the capital itself; whilst, according to the scheme substituted in its stead, it was provided that the old form of government should be entirely dissolved;—that five Prytanes should be elected;—that these five should choose a hundred others, and each of the hundred choose three more;—that the Four Hundred thus elected should become

a senate with full power, but should nevertheless consult occasionally with Five Thousand of the wealthiest citizens, who alone were henceforth to be accounted The People;—and that no authority whatever should remain in the hands of the lowest class of citizens. Such was the scheme proposed by Pisander; and although the people were opposed to this change, those who conducted it, being men of great parts, found means to establish it by one of those uncere- monious acts of audacity which commonly distinguish re- volutions in popular governments.

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In the meanwhile the Athenian army having changed their mind, declared for a democracy; and recalling Alci- biades, they invested him with full power, and insisted on his immediate return to Athens for the purpose of restoring the ancient government. But he peremptorily refused to comply with their wishes; persuaded them to stay where they were in order to save Ionia; and further prevailed on them to allow some deputies, who had been sent by the new governors of Athens, to deliver the message with which they were charged. When the deputies had done so, Alcibiades enjoined them in reply to return immediately to Athens, and acquaint the Four Hundred that they were commanded instantly to resign their authority and restore the senate; adding, that the Five Thousand might retain their power for the present, provided they used it with moderation. By this answer the city was thrown into the utmost confusion; but the party of the new government prevailing, ambassadors were dispatched to Sparta with orders to conclude peace upon any terms. This, however, was not so easy a matter as some had hastily imagined; for the Spartans proved intractable; and Phrynichus, the chief of the embassy, was murdered on his return. When the news of his death arrived, Thera- menes, the head of the democratical party, seized the leaders of the Four Hundred; upon which a tumult ensued that had almost proved fatal to the city itself; but the mob being at last dispersed, the Four Hundred immediately assembled, and sent deputies to the people, promising to comply with all their reasonable demands. A day was accordingly appointed for convoking a general as- sembly, and settling the form of government; but when it arrived, intelligence was brought that the Lacedæmonian fleet was in sight, and steering directly for Salamis. Thus all was again thrown into confusion; and the people, in- stead of deliberating on the subject proposed, ran in crowds down to the port, whence a fleet of thirty-six ships was im- mediately dispatched, under the command of Timochares, to engage the enemy, who were perceived to be making for Eubœa. But this fleet was utterly defeated, twenty- two ships being taken, and the remainder either sunk or disabled; and this disaster was followed by the revolt of all Eubœa, except the small district of Orcus. When the dismal tidings reached Athens, every thing was given up for lost; and had the Lacedæmonians taken this opportu- nity of attacking the city, they would undoubtedly have succeeded in the attempt, and thus put an end to the war by the subjugation of Athens. But being at all times slow, especially in naval affairs, they allowed the Athenians time to equip another fleet, and to retrieve their affairs; while Alcibiades, by his intrigues, so effectually embroiled the Persians and Peloponnesians that neither party knew whom to trust, and mutual distrust at length rose to such a pitch as almost to involve them in open hostility; and several advantages gained by the Athenians at sea tended to re- vive their hopes and restore their confidence.

The army
declares
for a de-
mocracy.

During the succeeding years of this celebrated war the Alci- biades Athenians were also in the first instance very successful. Thrasybulus obtained a signal advantage at sea; and in the same day Alcibiades gained two victories, one by land and another by sea, capturing the whole Peloponnesian fleet,

Alcibiades
triumph-
ant and
disgraced.

Attica.

besides an immense spoil. The Spartans, humbled by these reverses, were reduced in their turn to the necessity of suing for peace. But the Athenians, intoxicated with success, sent back the envoys without vouchsafing an answer to their proposals; and the Spartans, justly incensed at this insolent and contemptuous conduct, renewed the war with the utmost vigour, and soon after made themselves masters of Pylos. Nor was this the only misfortune of the Athenians. The Megarensians surprised Nysæa, and put the garrison to death; an act which so exasperated the Athenians that they immediately sent an army against that people,—defeated them with great slaughter,—and committed horrid devastations, in revenge for the affair of Nysæa. But these misfortunes were still in some measure counterbalanced by the great actions of Alcibiades, Thrasybulus, and Theramenes. Indeed, when Alcibiades returned in triumph to Athens, he brought with him a fleet of two hundred ships, together with such a load of spoils as had never been seen in the capital since the conclusion of the Persian war. The people crowded to the port to behold the hero as he landed; old and young blessed him as he passed; and next day, when he had delivered a harangue to the assembly, they directed the record of his banishment to be thrown into the sea, absolved him from the curses he lay under on account of the alleged sacrilege, and created him generalissimo of their forces. But this enthusiasm was too violent to be lasting; and in point of fact a casual reverse which Alcibiades sustained soon after this obliterated all remembrance of his former services, and involved him in disgrace. Having sailed to the Hellespont with part of his fleet, he left the remainder under the command of Antiochus his pilot, with strict orders to attempt nothing in his absence. But the pilot chose to disobey his instructions, and having provoked Lysander the Lacedæmonian admiral to an engagement, he paid for his temerity by a total defeat, with the loss of fifteen ships, and that of his own life into the bargain. On receiving intelligence of this disaster, Alcibiades returned, and endeavoured to induce the Lacedæmonian commander to hazard a second battle; but Lysander was too prudent to incur such a risk; and in the meanwhile the Athenians, with their usual ingratitude and inconstancy, deprived Alcibiades of his command, and named ten new generals in his stead. By this iniquitous proceeding their ruin was sealed. Conon, who succeeded to the command, was beaten by Callicratides, Lysander's successor; but being afterwards strongly reinforced, he retrieved this disgrace by defeating the Lacedæmonians with the loss of no less than seventy-seven ships. Such a victory might have been supposed to inspire the Athenians with some gratitude towards the generals who had gained it; but instead of this eight of them were recalled, on pretence of their not having assisted the wounded during the engagement: two were prudent enough not to return; and the six who trusted to the justice of their country were all put to death without mercy.

Athenians
defeated at
Ægosop-
tami.

The following year Lysander, appointed commander of the Peloponnesian fleet, succeeded in capturing both Thasus and Lampsacus. Conon was immediately dispatched against him with a hundred and eighty ships; a force so superior to that under Lysander, that the Lacedæmonian declined accepting battle, and was consequently blocked up in the river Ægos. While the Athenians lay there observing him, they grew quite idle and careless, insomuch that Alcibiades, who had built a habitation for himself in the neighbourhood, entreated them to be more watchful, as he well knew Lysander's great abilities, and dreaded that they might have reason to repent their security if they disregarded his advice. They replied by expressing their wonder at the assurance of a fellow who was an exile and

a vagabond, in pretending to offer advice to them; adding, that if he gave them any further trouble, they would seize and send him a prisoner to Athens. The consequences of such conduct may easily be imagined. Lysander fell unexpectedly upon the presumptuous fools, and gained a complete victory; Conon, with only nine galleys, escaping to Evagoras at Cyprus: after which the Lacedæmonian commander returned to Lampsacus, where he put to death Philocles with 3000 of his soldiers, and the whole of the officers except Adimantus. He then reduced all the cities subject to Athens, and artfully sent home their garrisons, that the city, overstocked with inhabitants, might thus be rendered incapable of holding out for any length of time when he came to besiege it.

Nor was any time lost in undertaking this decisive operation. Lysander appeared before the harbours with a fleet; while Agis, at the head of a powerful army, invested it on the land side. For a considerable time the Athenians resisted both attacks; but they were at last forced to send deputies to Agis, who referred them to Sparta; and when they repaired thither they were told that no terms could be granted except they consented to demolish their walls. They next applied to Lysander, but he also referred them to Sparta; to which Theramenes, with other deputies, was immediately dispatched. On their arrival they found assembled the council of the confederates, who all except the Spartans gave their votes for the utter destruction of Athens; but the latter would on no account consent to the ruin of a city which had deserved so well of Greece. The Athenian envoys did all in their power to mitigate the severity of the terms, but without effect; and finally peace was concluded, on condition that the long walls and the fortifications of the port should be demolished, and that the Athenians should deliver up all their ships excepting twelve, receive back such as had been banished for political offences, and consent to follow the fortune of the Lacedæmonians. And these severe terms were punctually executed. Lysander caused the walls and fortifications to be pulled down; established an oligarchy expressly against the will of the people; and thus completed the ruin of Athens in the twenty-seventh year of the Peloponnesian war, and the 404th B. C.

As soon as the Lacedæmonian had demolished the long walls and the fortifications of the Peiræus, he constituted a council of thirty, with power, as was pretended, to make laws, but in truth to subjugate the state. These were the persons so famous in history under the title of The Thirty Tyrants. They were all the creatures of Lysander; and as they derived their power from conquest and the law of the sword, they exercised it in a manner worthy of its origin. Instead of making laws, they governed without them; they appointed a senate and magistrates at their will; and, lastly, they applied for a garrison from Lacedæmon, that, under the protection of a foreign military force, they might give a freer and bolder scope to the licentiousness of tyranny.

Critias and Theramenes, two men of the greatest power and abilities in Athens, were at the head of this odious oligarchy. The former was ambitious and cruel beyond measure; but the latter was of a more merciful and humane disposition. The one pushed on all the bloody schemes framed by his confederates, and carried into execution many of his own; the other always opposed them, at first with moderation, at last with vehemence. In the course of his expostulations he said, that power was given them to rule and not to despoil the commonwealth; that it became them to act like shepherds, not like wolves; and that they ought to beware of rendering themselves at once odious and ridiculous, by attempting to domineer over all, being a mere handful of men, whom the slightest resistance would crush. This hint was not thrown away; for the remaining

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Capture of
Athens.

The Thir-
ty Tyrants.

Critias and
Therame-
nes.

Attica. oligarchs immediately chose three thousand persons, whom they constituted the representatives of the people, and on whom they granted the notable privilege of not being liable to be put to death except by judgment of the senate; thereby assuming by implication a power of sacrificing the other Athenian citizens at their pleasure. Nor were they slow in practically confirming the justice of this interpretation; for as many as they conjectured to be unfriendly to the government in general, or to any of themselves in particular, they put to death, without cause and without mercy. Theramenes stoutly resisted this wantonness of cruelty; and absolutely refusing to concur in such measures, Critias accused him to the senate as a man of unsteady principles, sometimes for the people, sometimes against them, and favourable to nothing except innovation and revolution. The accused admitted that he had sometimes changed his measures, but alleged that he had always done so for the benefit of the people. It was solely with this view that he made peace with Sparta, and accepted of office as one of the Thirty; nor had he ever opposed their measures while they cut off the wicked; but when they began to destroy men of fortune and family, then he owned he had differed with them, which he conceived to be no crime against the state.

Theramenes put to death. Whilst Theramenes was speaking, Critias, perceiving the impression made upon the senate by his words, withdrew abruptly; but he soon returned with a guard, crying out that he had struck the name of Theramenes out of the list of the three thousand; that the senate had therefore no longer cognizance of the cause; and that the Thirty had already judged and condemned him to death. Theramenes, seeing that they intended to seize him, fled to the altar in the midst of the senate-house, and laying his hands thereon, said, "I do not seek refuge here because I expect to escape death, or desire it; but that, tearing me from the altar, the impious authors of my murder may interest the gods in bringing them to speedy judgment, and thereby restore freedom to my country." The guards then dragged him from the altar, and carrying him to the place of execution, he drank the poison with undaunted courage; reminding the people, with his last breath, that the same tyrants who had arbitrarily struck his name out of the list of the three thousand, might also strike out any of theirs, and that none could say whose turn it might next be to drink the fatal cup which he had just drained. The death of this heroic man was followed by a train of murders such as are to be found recorded only in the annals of republican oligarchies or aristocratical republics. Almost every citizen of any eminence had either died a violent death or been driven into exile.¹

Tyranny overthrown. At length Thrasybulus, and such as like him had taken shelter in the Theban territory, resolved to hazard every thing rather than remain in a state of perpetual exile from their country; and although he had not more than thirty men on whom he could depend, yet, inspired by the remembrance of the victories he had heretofore obtained in the cause of his country, he boldly made an irruption into Attica, and seizing on Phyle, a castle at a short distance from Athens, numbers flocked to his standard, and he soon found himself at the head of seven hundred men, who, driven mad by cruelty and oppression, were prepared to devote themselves for their country. The tyrants of course had the disposal of the Spartan garrison, which they employed

to reduce Thrasybulus and his party; yet he prevailed in various skirmishes, and at last obliged them to decamp from Phyle, which they had intended to blockade. The Thirty and their partisans conceiving it expedient to obtain possession of Eleusis, marched thither; and having persuaded the people to go unarmed out of their city, on the pretence of numbering them, the monsters instantly commenced an indiscriminate massacre. But the forces of Thrasybulus increasing daily, he seized on the Peiræus, which he fortified in the best manner he could; and although the tyrants came down against him with the utmost force they could raise, he defended himself with so much obstinacy, that in the end they were forced to retreat, having lost before the place not only a great number of their men, but Critias, the president of the Thirty, and other members of this sanguinary oligarchy. By this gallant resistance the fate of the oligarchy was sealed. The people indeed differed among themselves; and the sanguinary monsters, who during their short administration had destroyed more men than had fallen during half the Peloponnesian war, had still a considerable party in Athens. But happily the cause of humanity prevailed; the tyrants were expelled, and ten men of each tribe were chosen to govern in their stead.

But although the citizens had changed the government, Spartans they had made no agreement with those in the Peiræus;² whilst the tyrants, who had retired to Eleusis, sent deputies to Lacedæmon to announce the revolt of the Athenians, and request assistance to reduce them. Nor did their application prove fruitless. Besides remitting them a large sum of money to aid their intrigues, the Lacedæmonians appointed Lysander commander-in-chief, and his brother admiral; resolving to send both a fleet and an army, in order to reduce Athens a second time, and, as most of the Greek states then strongly suspected, to add it to their other dominions. Nor is it improbable that this design would have taken effect, had not Pausanias, the rival and enemy of Lysander, resolved to obstruct it by every means in his power. With this view he caused another army to be raised, of which he took the command, and immediately marched for the ostensible purpose of besieging the Peiræus. But while he lay before the place, and pretended to attack it, he entered into a private correspondence with Thrasybulus, instructing him what propositions to make in order to induce the Lacedæmonians, who were suspected by their allies, to abandon the contest, and conclude peace upon equitable terms. These intrigues had all the success that could be desired. The Ephori who were with Pausanias in the camp concurred in his measures; and in a short time a treaty was concluded, by which, amongst other things, it was provided that all the citizens of Athens should be restored to their homes and privileges, with the exception of the Thirty, the Ten who had succeeded them, and the Eleven who during the time of the oligarchy had been constituted governors of the Peiræus; that all should remain quiet for the future in the city; and that, if any persons were afraid to trust to this agreement, they should have permission to retire unmolested to Eleusis. Pausanias then marched away with the Spartan army; and Thrasybulus at the head of his forces entered Athens, where, having laid down their arms, they sacrificed with the rest of their fellow-citizens in the temple of Minerva, and then, to the

¹ Alcibiades died during the tyranny of the Thirty. He was then in the forty-fourth year of his age, and had been more or less engaged in public affairs for about twenty years. He was a bold, bad man; of great personal and mental endowments, but utterly devoid of principle, and addicted to the most shameless profligacy; prompt, skilful, brave, enterprising, restless, ambitious, yet fond of intrigue and finesse in all things; an enemy to liberty under the mask of ultra-democracy; and reckless of every consideration which was opposed to the gratification of his pride, vanity, ambition, sensuality, revenge, and love of perpetual bustle and turmoil.

² Οἱ τῶν Πειραιῶν, that is, Thrasybulus and his party.

Attica. great delight of all, restored the popular form of government, which was afterwards consolidated by an act of general amnesty and oblivion.¹

Virtue of
Thrasybulus.

Throughout the whole of this transaction the conduct of Thrasybulus was admirable. When he first seized the castle of Phyle, the tyrants privately offered to receive him into their number instead of Theramenes, and to pardon at his request any twelve persons whom he might choose to name. But he nobly replied that he considered his exile far more honourable than any authority could be, purchased on such terms; and by persisting in his design he accomplished the deliverance of his country from a ferocious and sanguinary oligarchy, which, as Isocrates informs us, had put fourteen hundred citizens to death without any form of law, and had driven five thousand more into banishment, besides committing a variety of other acts of cruelty and oppression.

But, although Athens was thus restored to liberty by the virtuous patriotism of Thrasybulus, the age of Athenian glory had passed away. From this period till the reign of Philip of Macedonia the republic gradually sunk in energy, though it still continued to enjoy tolerable prosperity; and although many of the great masterpieces of Athenian genius were the productions of a later age, the most splendid of these only serve to prove beyond all question that the national spirit had degenerated, and that, "sunk in its glory, decayed in its worth," the Athenian Demos, which had once been the wonder and terror of the world, was now prepared to receive the law from the hands of almost any master. Philip accordingly found but little difficulty in extinguishing the feeble remains of liberty; and his son Alexander having completed the subjugation of Greece, the history of the Grecian states henceforward ceases to be of almost any interest. With regard to the capital, however, a rapid sketch of its history from this period till the present time will be found under the article ATHENS, to which reference is accordingly made.

Having thus laid before the reader an outline of the general history of Attica, it now only remains to give, as briefly as possible, some account of the character, government, religion, and public economy of the Athenians.

Character
of the
Athenians.

National character may be defined the aggregate of those qualities or peculiarities, physical, moral, and political, by which one community of men is distinguished from another; in other words, it is a complex result produced by the action and re-action of primary and secondary causes, or the joint effect of all the circumstances, original and accidental, in which a people happens to be placed. But these causes are so various, both in kind and degree,—the operation of one is so much affected and modified by that of another, and direct physical become so much blended with indirect moral and political influences,—that, whilst it is comparatively an easy matter to determine in what respects the general characters of nations differ, it is exceedingly difficult, not to say impossible, to resolve that of any one into its constituent elements, and to assign to each its due share in the production of the ultimate result. The instrument of analysis which, employed in the investigation of physical laws, has led to the discovery of the most sublime truths, and extended the knowledge and consequently the power of man over the material world, is applicable only in a very limited degree even to the most complex phenomena of mind. Here we possess no manner of control over the subject of our inquiries; we have no power of placing it in new situations, of trying it by a variety of tests, or of submitting it to a course of skilfully-contrived experiments. All that we can possibly do is either carefully to watch its

manifestations, where these fall under our own notice, or to apply the principles of a sound logic to such observations as have been recorded by others, and thus to endeavour to make the nearest approximation we can to the truth. In such a method of investigation, however, the liability to error must necessarily be great; for, independently of its own obvious imperfection, the subtle nature of the phenomena observed, and the constant transitions and modifications they experience, produce continual mistakes upon the part of the observer; whilst the spirit of system or of theory, which is generally most active where our knowledge is least accurate and extensive, instead of facilitating the correction of such mistakes, contributes rather to render them inveterate, and thus opposes a serious obstacle to the progress of sound inquiry. In attempting to form a judgment of the national character of a people, therefore, it becomes us to be equally on our guard against dogmatism in the statement of facts, and rash generalization in the inferences deduced from them. The former, indeed, are but too frequently stated without the qualifications proper to be applied to them; the latter is almost certain to lead into error and mystification. In cases where physical and moral causes are blended together in their operation; where primary results experience endless modifications from the influence of circumstances and the re-active working of positive institutions; and where we are in possession of no instrument of analysis by which the complex whole can be reduced into its constituent parts or elements; it is manifest that no theory which human ingenuity can invent will ever be sufficient to explain all the phenomena of national character, or to account for the varied and often incongruous phases which it assumes. Some writers, for instance, have amused themselves with referring to the influence of climate all the varieties observable in the characters and institutions of different nations; whilst others, again, have ascribed to the joint effect of moral and political causes, operating under peculiar circumstances, the diversities in question. But it must be obvious, on the slightest consideration, that both these theories are equally untenable, inasmuch as national character is not the result of one cause or set of causes, but of all the causes and influences, of whatever kind, which act, either directly or indirectly, upon the general mind of a people. Instead of attempting to generalize, therefore, where generalization is from the very nature of things inadmissible, let us endeavour simply to point out some of the leading features in the character of that illustrious nation which in ancient times inhabited the territory of Attica, and filled the world with the renown of their achievements both in arts and in arms.

The Athenians surpassed all the other Greeks in physical conformation no less than in mental endowments. Among this people, indeed, strength and symmetry of body were happily united with many of the rarest attributes of mind. For these advantages they were indebted partly to nature, and partly to a system of education, which, apparently limited and imperfect, was nevertheless singularly calculated to develop their peculiar capabilities. Habitual exercise may not be capable of creating beauty of form originally, but it certainly tends greatly to improve it; and in the human frame elegance and grace are seldom divorced from the free and flexible vigour acquired in the palæstra. A similar observation may be applied to the human mind. Admitting that certain tribes or races of men are, taken as a whole, gifted by nature with finer faculties, nicer perceptions, and more acute sensibilities, than others, no one can doubt that these may be prodigiously improved by

Attica.

¹ The whole of this war lasted ten months. (Xenophon, ii. 4, 43.)

Attica. education; which, in fact, is to the mind what the chisel of the sculptor is to the rude block of marble,—that which fashions it, by scarcely perceptible degrees, into the fairest proportions, and gives animation and expression to that which was originally inert and lumpish. The Athenians were early sensible of this important truth; and although, till the age of Pericles, the three principal preceptors of their youth were the grammarian, the teacher of music, and the master of the gymnasium, yet even this limited circle of instructors was not ill adapted to call forth and keep in exercise the peculiar faculties for which they were so remarkably distinguished, and to prepare them for a more extended range of instruction. To the study of music, indeed, they were enthusiastically devoted, because in that delightful art they found a natural scope for the gratification of those nice and delicate perceptions which constituted a prominent characteristic of their minds;¹ nor will its union with the study of grammar be deemed surprising, when we reflect, that it was probably this circumstance, aided by an organic and intellectual sensibility altogether unrivalled, “which gave form to the most harmonious language ever spoken among men, and guided invention to the structure of that verse which, even under the gross disguise of modern pronunciation, is still universally charming.”² But there were other elements in the Athenian character besides a love of music, poetry, and the fine arts, to which both nature and education had contributed to form them.

Speaking of this people, Plutarch, after describing them as at once passionate and placable, prone to anger yet easily appeased, goes on to observe, that their minds were not formed for laborious researches, and that although they seized a subject as it were by intuition, yet they wanted the patience and perseverance requisite for a thorough examination of its various bearings and ramifications. An observation more superficial in itself, and arguing a greater ignorance of the real character of the Athenians, cannot easily be imagined. That they were remarkable for ardour and vivacity of temperament, quickness of sensibility as well as of apprehension, and versatility of feeling as well as of genius, has not been disputed. But there is nothing in all this which necessarily pre-supposes or implies an incapacity for the prosecution of subjects requiring patient thought and persevering attention. The French, in point of national character, hold nearly the same relative place among the modern nations of Europe, that the Athenians held among the states of ancient Greece; yet it is matter of notoriety, that in the cultivation of the natural and the exact sciences, that is, in the prosecution of those subjects where patience and perseverance are pre-eminently indispensable, they have for a considerable time outstripped all competition, and now bear the palm alone. This was precisely the case with the Athenians. A love of profound research and curious speculation seems to have been as inherent in their character, and as congenial to their national temperament, as a love of poetry, music, and the fine arts.

Love of speculative inquiries. The fire which Thales lighted up was never afterwards wholly extinguished amongst them. He had kindled his torch at the altar of science in Egypt, and it burned brightly in the propitious atmosphere to which it was transferred by the father of Greek philosophy. The Ionian school, of which this philosopher became the founder, was followed in quick

succession by the Italian and Eleatic, where the physical and metaphysical sciences were cultivated with equal success; and in the dialogues of Plato ample evidence may be found of the zeal and ardour with which the laws both of mind and of matter were investigated in Athens, as soon as the violence of political contention had subsided, and a respite from wars and revolutions gave leisure for the discussion of such subjects. God, the Universe, and Man, at once divided and engrossed the whole of their attention. The question first asked was, What is God? and to this various and discordant answers were of course necessarily given. According to Thales, he is the most ancient of all things, for he is without beginning; he is air, said Anaximenes; he is a pure mind, quoth Anaxagoras; he is both air and mind, contended Archelaus. Democritus thought him mind in a spherical form; Pythagoras, a monad and the principle of good; Heracleitus, an eternal circular fire; Parmenides, the finite and immovable principle, in a spherical form; Melissus and Zenon, one and every thing, the only eternal and infinite. But these answers, being all more or less physical, did not satisfy the question; a vacuity was still left; and Necessity, Fate, and Fortune or Accident, were the principles called in to fill it up. The Universe gave rise to another set of disputations. According to some, what is, has ever been, and the world is eternal; others, again, argued that the world is not eternal, but that matter is eternal. And here a multitude of questions arose. Was this matter susceptible of forms, of one or of many? Was it water, or air, or fire, or an assemblage of corpuscular atoms, or an infinite number of indestructible elements? Had it subsisted without movement in the void, or had it an irregular movement? Did the world appear by intelligence communicating its action to it, or did the Deity ordain it by penetrating it with a part of his essence? Did these atoms move in the void, and was the universe the result of their fortuitous concourse? Are there but two elements in nature, earth and fire, and by these are all things produced; or are there four elements, whose parts are united by attraction and separated by repulsion? In a word, “causes and essences; bodies, forms, and colours; production and dissolution; the great phenomena of visible nature, the magnitudes, figures, eclipses, and phases of the two heavenly luminaries; the nature and division of the sky; the magnitude and situation of the earth; the sea with its ebbs and flows; the causes of thunder, lightning, winds, and earthquakes;—all these furnished disquisitions, which were pursued with an eagerness of research and intenseness of application peculiar to the Greeks.”³ Nor did Man form a subject of less interesting and curious speculation than the universe of which he was considered an epitome. All allowed him a soul and an intelligence, but all differed widely in their ideas respecting this soul or intelligence. Some maintained that it was always in motion, and that it moved by itself; others thought it a number in motion; some considered it the harmony of the four elements; others, again, variously represented it as water, fire, blood, a fiery mixture of things perceptible by the intellect, which have globose shapes and the force of fire, a flame emanating from the sun, an assemblage of fiery and spherical atoms, like those subtile particles of matter which are seen floating in the rays of the sun.

Such were a few of the speculations which science had devised for employing the thoughts of the active-minded

¹ “What the music of the ancients ever was, we have now, as a very competent observer (Mitford, *Hist. of Greece*, vol. i. p. 151) remarks, little means of judging, as none of it has been transmitted intelligible to us; but that the Grecian music, even from the earliest times, had extraordinary merit, we have Plato’s testimony in very remarkable words (*Minos*, 46; *Convivium*, 333); and Aristotle, who, according to Montesquieu, had two ruling motives to guide his decision, affection for Alexander, and a jealousy against Plato, upon this subject (*Polit.* l. viii. c. 5) coincides in judgment with his great master.” (Mitchell’s *Aristophanes*, prel. disc. p. xxxv. xxxvi.)

² Mitchell’s *Aristophanes*, prel. disc. *ubi supra*.

³ *Ibid.* p. xli. et seqq.

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men in Greece, particularly in Attica; and when to these we add the ethical and political systems of the Academy, the Lyceum, the Porch, and the Gardens, to say nothing of that of the New Academy founded by Arcesilaus, and ably maintained by Carneades, or of the attention paid by almost all the philosophers to the cultivation of pure geometry, some idea may be formed of the extent of Plutarch's misrepresentation of the Athenian mind, when he described it as incapable of pursuing laborious researches, and as wanting in persevering and continuous attention. The very reverse of this, as has just been shown, was the truth; and, independently of the exemplification of a similar capacity for deep and laborious researches on the part of a modern nation, whose character in many particulars resembles that of the ancient Athenians, it is no more than a sound view of the principles of human nature might, anterior to all experience, have led us to anticipate. For, as travellers often reach the same destination by different routes, so men frequently pursue the same course from different motives or impulses. In the prosecution of scientific investigations, for instance, the Frenchman and the German are each persevering and laborious. But the former is impelled by an ardent curiosity and an overmastering ambition, which concentrate the whole energies of his mind on the subject which has powerfully attracted his attention, and merge all his feelings and desires in the attainment of one great object. The latter, without effort and without enthusiasm, perhaps with no definite object of ambition in view, pursues a similar career, because it belongs to his phlegmatic and passionless nature to persevere in whatever he may have undertaken or commenced. The principles by which these inquirers are set in motion are different, and the rates of advancement consequently unequal; but diligent and persevering labour is nevertheless alike predicable of each. The one travels, so to speak, in a light chariot, and compasses the distance to be travelled over at an accelerated pace; the other trundles it slowly along in a heavy lumbering post-waggon, but in time he also reaches the same destination. This analogy will probably serve to bring out the distinction here pointed at, and which indeed it is necessary to keep steadily in view, in order to form a just conception of the Athenian character. The native of Attica may be considered the Frenchman of Greece; quick, lively, sensitive, versatile, inconstant, full of that mercurialized spirit which shows itself equally in extreme delicacy of organic perception, and intuitive rapidity of mental apprehension; yet endued with an ardent and unquenchable curiosity, together with an inherent taste for subtle and abstract speculations, under the joint influence of which he was capable of penetrating the most recondite mysteries of science. Much of the excellence attainable in art is doubtless due to superiority of physical constitution and of natural character; but in science, although original genius will always assert its pre-eminence, and distinguish itself by the felicity of its intuitions, unremitting labour is the *conditio sine qua non* of great and signal success; and it is not a little remarkable to find this condition so strikingly exemplified in the character of a people, whose more obvious qualities would seem incompatible with steady concentration of thought, and whom a superficial observer has accordingly pronounced incapable of that intense, resolute application, which, in fact, constituted one of their most distinguishing national peculiarities.

Effects of political institutions.

Politically considered, the Athenian character took by reflection the hue of those republican institutions to which it had originally given birth; and this, blending and intermingling with its natural lights and shadows, produced a composite mass, which moral analysis unfortunately has no prismatic power of resolving into its primary elements.

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Love of liberty, however, as liberty was then understood, formed the ruling principle as well as passion of the people. An equality of political rights, or, in other words, an equal right in all free citizens to aspire to the exercise of political power, constituted the essence of the Athenian form of government. It was for the most part a despotism under the disguise of republican forms, and, even in its best times, it may be described as the tyranny of all over all. Civil liberty, the benign discovery of modern times, was then unknown, or at least unenjoyed, and, indeed, is scarcely compatible with a purely democratical form of polity. Political equality was the only species of liberty understood or enjoyed in the ancient republics, and in those of Italy during the middle ages. It was this which had so powerful charms for the citizens of those democracies; it was this of which they were so passionately enamoured; it was this which gave so effective a stimulus to all the faculties of the human mind, and produced those wonders of genius and of art which have exhausted the admiration, and rendered hopeless the rivalry, of succeeding times. The glory of the country in fact formed the glory of every citizen belonging to it; and he felt himself directly participant in all that contributed in any way towards its aggrandizement or renown. For a short time, indeed, an oligarchical usurpation might oppress the people, or the ambition of a fortunate soldier or crafty statesman might prove dangerous to liberty; but a sudden popular explosion might overturn the one, and the ostracism expel the other; whilst, in the frequent revolutions of the wheel of fortune, he who occupied the lowest station to-day might by to-morrow be elevated to ambition's utmost round, and in a condition to give the law to those from whom he had lately received it. The re-action of such a political system upon the national character could not fail to be powerfully marked. Its immediate products were extreme jealousy of those intrusted with power, and an incessant watchfulness over all their proceedings; an intense, passionate detestation of tyrants and tyranny; an ardent and active zeal in defence of public liberty when assailed, whether from within or from without; overweening nationality of feeling, mixed with no small degree of contempt and even aversion for the natives of other less favoured states; and, we fear it must be added, a spirit of aggression and conquest singularly at variance with that love of liberty which free institutions naturally inspire. Factious turbulence, inconstancy, and love of change, may also be numbered amongst the effects of a system of government purely democratical; and, paradoxical as it may seem, these for a time constitute its best if not its only safeguards. A democracy, in truth, is little else than revolution systematized; nor is there any thing which is so much calculated to endanger its existence, if not to bring about its entire subversion, as any relaxation in that jealous watchfulness which leads the people constantly to suspect, distrust, and combine against those invested with power. Much has been said and written about republican ingratitude, which, indeed, has long been proverbial; but those who declaim on this theme do not reflect, that while the vice in question is not the peculiar reproach of democracy, the essence of that form of government consists in anxiously guarding against the aggrandizement of individuals or classes, and in crushing every aspirant who attempts to raise his head above the common level. Republics have often had occasion to regret their rewards, seldom their punishments.

If we are not greatly mistaken, these observations furnish a key to the right intelligence of the Athenian character, the leading features of which were unquestionably moulded and fashioned by their political institutions. They were fickle, versatile, liable to sudden gusts of passion, but easily appeased; inconstant in their affections, General results.

Attica. but not implacable in their hatreds; jealous, factious, turbulent, impatient of command, and prone to resent the assumption of superiority; attentive to the information and instruction afforded them by eminent citizens, yet intolerant of dictation, and, in their best days, ready to repress an overgrown and dangerous reputation; fond of flattery, and too apt to lend a delighted ear to the adulation of sycophants or demagogues, but not insensible to virtue, nor unwilling to listen to those honest patriots who proved their sincerity by courageously exposing the vices and follies of their countrymen; brave in the field, and liable to be excessively elated with victory or depressed with misfortunes, but seldom chargeable with dishonouring success by inhumanity to the vanquished, or deepening the disgrace of defeat by humiliating or abject concessions to the victor; generous in their sentiments; bold and free in their opinions; invariable in their sympathy with and admiration of genius; constant in their love of liberty and their country; and never backward to repair the errors or injustice committed under the influence of pernicious advice, passionate excitement, or the headlong impetuosity of an ardent and uncontrollable temperament. In their private conduct they were courteous, mild, humane, polished, liberal, and enlightened; simple in their manners, frugal in their habits, and but little addicted to any kind of ostentation or parade, even after their victories had brought them in contact with oriental luxury, and when their riches enabled them to rival in costliness and in splendour the nations whom they conquered. All their sumptuousness and magnificence was reserved for and lavished on those public edifices and monuments of art which made Athens the pride of Greece, the envy of the surrounding nations, and the admiration of the world at large. Such was the Athenian Demos in the days of its glory and independence, when, by the mouth of Aristides, it declared to the ambassadors of the Great King, "that it was impossible for all the gold in the world to tempt the republic of Athens, or to prevail with it to sell its liberty and that of Greece," and when public virtue maintained the purity and vigour of public institutions.

Government. During the period which elapsed from the abolition of royalty till the appearance of Solon in the character of a lawgiver and codificator, the constitution of the Athenian government experienced frequent mutations. To the kings succeeded the hereditary archons, who held their office for life, and were in fact sovereigns under another designation. Of this the people were at length sensible; and, accordingly, on the death of Alcmaeon (B. C. 647), Charops was raised to the archonship upon the condition of holding it for ten years only. He was followed in succession by six others, who exercised the functions of the office under the same decennial limitation. But on the expiration of the archonship of Eryxias, a further and greater change took place. The duration of the office was limited to a single year, and its duties were divided amongst nine persons, chosen by lot out of the first order of the state, the eupatrids or nobles only. These functionaries all bore the title of archon, but differed in dignity as well as in the particular nature of their duties. The first in rank, called Archon Eponymus, or simply the archon, represented the majesty of the state, and by his name the year of his magistracy was distinguished; the second bore the title of king, and was the head of the religion of the commonwealth, to the care and protection of which his functions principally related; and the third, or polemarch, was originally a sort of minister at war or commander-in-chief. The six other archons, denominated thesmothetes, presided as judges in the ordinary courts of justice, and formed together a tribunal with a special jurisdiction. The nine together constituted the Council of State. The legislative functions remained with the assembly of the people;

Attica. but the whole executive powers of the state, political, military, judicial, and religious, were exercised by the archons.

This is the substance of the information derived from the ancient authors respecting the Athenian government at the period to which we refer; but as writing had hitherto been little practised in Greece, and as laws were promulgated orally and preserved by tradition, it is necessarily scanty and imperfect; nor was it possible, under such circumstances, that the sciences of legislation and government should receive any material improvement, or the rights and interests of the many meet with due respect and attention, when the authority of the state was lodged in the hands of an irresponsible few. The commonwealth was distracted by a perpetual scramble for the sovereign power, which, being open to all the principal families, some who could not obtain it by legal sought to grasp by illegal means. Factious ambition and lawless turbulence found equal scope for displaying themselves; and amidst continual alternations of despotism and anarchy, of usurpation and revolution, the intolerable evils of an unsettled government and an uncertain jurisprudence became deeply felt and almost universally acknowledged. A remedy was accordingly sought for in a stern and sanguinary code, which Draco about this period introduced; but the talents of the legislator were unequal to the task he had undertaken, and the indiscriminate severity of his system speedily defeated its own purpose. He made no attempt to reform the political constitution of his country, the real source of the miseries under which it groaned, but established a new penal code, which denounced the highest punishment against the most trivial offences as well as the most enormous crimes, upon the ground that the slightest breach of any positive law deserved death as treason against the jurisprudence of the state. A system so revolting to the natural feelings and sentiments of mankind could never be reduced into practice, nor rendered productive of any thing but evil; for every principle of reason and of humanity conspired to defeat its operation; and whilst its obvious tendency was to provoke the commission of heinous crimes, it at the same time multiplied the chances of impunity in favour of criminals. The laws of Draco, therefore, instead of applying a remedy to the evils of a defective system of polity, served rather to increase them, and to make the people feel strongly the necessity of a more radical and comprehensive reform than that which had been proposed by this stern and inflexible moralist. Nor was it long ere a change was effected in the constitution of the government, which laid the foundation of the Athenian system of polity properly so called, and which, though it subsequently underwent frequent and considerable alterations, may nevertheless be regarded as the basis of Athenian liberty. This was accomplished by Solon, one of the greatest characters that Greece ever produced, and one of the wisest men of whom any age or country can boast. We now accordingly proceed to give some account of his legislative labours, as these were embodied in the constitution which he reformed and remodelled on a plan suited to the circumstances and wants of his country.

By the fundamental law of this constitution the sovereign power was vested in the general assembly of the people. But an important question here arises, namely, Who were accounted The People, legally entitled, in their collective capacity, to the exercise of the supreme power of the state, as well as to provide effectually for the exclusion of those upon whom that high privilege had not been conferred? The population of Attica, or, in other words, the component members of the Athenian commonwealth, consisted of three classes, viz. Athenian citizens; resident aliens, or freemen liable to the capitation tax, who had

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not the rights of Athenian citizens; and slaves in actual bondage: and these classes differed from one another in numbers no less than in rank and condition. The number of citizens has been variously estimated, and, in point of fact, must have differed at different times. According to the census taken in the time of Pericles, they amounted to no more than 14,040 persons; but Mr Mitford conjectures¹ that this enumeration included only those above the age of thirty, who alone were competent to be admitted as jurymen or assessors for the trial of causes. In the first speech of Demosthenes against Aristogeiton, they are, however, reckoned at nearly 20,000; Plato, in his *Critias*, assumes the same amount for the most ancient times, having doubtless transferred the number that was commonly computed in his own day to the earliest periods of the state; and the modern Grecian writers, as Libanius, for instance, follow the same statement. But the enumeration made by Demetrius Phalereus gives more precise and definite results. According to this census, which was taken in the fourth year of the 117th Olympiad, there were 21,000 citizens, 10,000 resident aliens, and 400,000 slaves; an estimate which, according to the usual statistical rule of taking the adults as a fourth part of the population, would give for the total number of citizens 84,000, and for that of aliens 40,000; whilst the slaves, having no head or status of any kind in the commonwealth, are reckoned absolutely, comprehending under the 400,000 all those in actual bondage, men, women, and children, without distinction of age or sex. But, from various considerations, into which it is unnecessary to enter, Boeckh has shown² that the census of the archon requires considerable modifications; and, upon grounds which appear to be completely conclusive, he reckons the free inhabitants at 90,000, the resident aliens at 45,000, and the slaves at 365,000, together with women and children, which latter, however, were proportionally few. Assuming this estimate, then, as a pretty close approximation to the truth, it follows that the number of adult citizens was above 22,000, and that The People, in the political sense of the term, consisted of only about a twenty-third part of the entire population of the country. It is of the greatest importance to keep this fact steadily in view, as it has an immediate bearing upon the whole political system of the Athenians, and serves to reconcile many apparent anomalies by which superficial inquirers have been so often perplexed and misled. Nothing indeed can be more erroneous than the notion, which has been repeatedly promulgated, that the Athenian constitution was purely democratical. On the contrary, it was, in the strictest sense of the term, a republican aristocracy,—the whole power of the state being vested in the privileged class called citizens, who, as we have just seen, constituted but a small portion of the entire population; whilst the two other classes had no recognised political existence whatsoever, and that which was by far the most numerous remained in a state of more abject servitude than the villains under the feudal system or the serfs in Russia and Poland.

Assembly
of the
people.

We have already said that, by the fundamental law of the Athenian constitution, the sovereign power was vested in the general assembly of the people. This body consisted of all the citizens, or privileged class, who had attained a certain age; excepting such as had been attainted and rendered infamous by a judicial sentence. Yielding to the temper of the times and the force of circumstances, Solon confirmed to this body an authority universally and uncontrollably absolute; yet, with singular inconsistency,

he at the same time sought to establish a balancing power, capable in some measure of restraining the excesses into which a sovereign multitude is ever ready, on the slightest excitement, to plunge. With this view he made a new division of the people into four ranks or classes, according to the relative value of their possessions or property. The first rank consisted of those whose lands produced annually five hundred medimni of corn, wine, oil, or any other commodity, dry or liquid; and who were hence called Pentacosiomedimnians. The second rank was composed of persons whose lands yielded at least three hundred measures, and who were denominated Hippeis; because although enjoying the same exemption as the first rank from service in the infantry or on shipboard, they were bound to maintain, at their own charge, a horse for the public, and, within the military age, to serve personally in the cavalry. The third rank, or Zeugites, consisted of those whose lands produced upwards of two hundred, but less than three hundred measures, and who were bound to serve in the infantry of the line (*ὀπλιται*), and to be completely provided with arms for the purpose. The rest of the citizens not possessed of lands yielding two hundred measures were comprehended under the name of Thetes, and were also liable to military service either in the infantry of the line or among the light troops, according as they chanced to be provided with arms; and when Athens afterwards became a maritime power, it was also from this class that the fleet was principally manned. The diligent researches of Arbutnot show the extreme difficulty, or rather impossibility, of ascertaining, by modern standards, the precise relative value of an Attic estate in the age of Solon; but it seems to be tolerably clear that the object and intention of the Athenian lawgiver in forming such division, was to give to property a preponderance over numbers; and, accordingly, by his constitution, it was expressly provided that the magistracies should be filled from the first, second, and third ranks, to the exclusion of the fourth. But the policy of this arrangement was completely neutralized by leaving the appointments to be made by popular election, and admitting the fourth rank to the exercise of the right of voting in common with the others; for the poorest class being in all societies the most numerous, an equality of suffrage in the sovereign assembly of the people, combined with a difference of rank not founded in exclusive political privileges so much as on the grosser and more invidious distinction of wealth or riches, sufficed to unite the highest number against the greatest amount of property; to overturn the feeble and exceedingly artificial barriers which Solon had reared up; and ultimately to place unlimited power in the hands of those who may fairly be supposed the least capable of exercising it with judgment or moderation.³ The Athenian lawgiver, therefore, committed a grave practical error, highly favourable indeed to the development of the democratical spirit, but wholly inconsistent with that system of checks and counterpoises which it seems to have been one great object of his legislative labours to organize, and render effectual in restraining the indiscretion of the multitude.

Another of Solon's balancing expedients was the institution of a council or senate, consisting of one hundred persons chosen out of each of the four wards or districts into which the people of Attica were divided, or four hundred in all, but afterwards raised to five hundred, when the number of wards or districts was increased to ten, and fifty counsellors or senators allotted for each. Its common designation was, The Council; but, for the sake

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¹ *History of Greece*, vol. i. p. 367. London, 1830, 8vo.

² *Public Economy of Athens*, vol. i. p. 49, et seqq. Engl. Transl. London, 1828.

³ Mitford's *History of Greece*, vol. i. p. 371, et seqq.

Attica. of distinction, it was called The Council of Five Hundred, or simply The Five Hundred. The members were chosen annually by lot from among those who were legally qualified for the office and desirous of obtaining it; but, prior to their admission, they had to undergo, before the existing council, a strict scrutiny, termed *Dokimasia*, concerning their past life, and if any thing prejudicial to their character came out in course of the inquiry, they were rejected. The counsellors of each tribe, in turn, for the space of thirty-five days, enjoyed superior dignity and additional authority under the title of *Prytanes*; and from them the council-hall or place of meeting was denominated *Prytaneium*. The *Prytanes* officiated in turn as presidents of the council, each holding the office only one day, during which he had the custody of the public seal, with the keys of the treasury and those of the citadel; and the whole assembly formed the Council of State of the commonwealth. This body, partly deliberative and partly executive, had the initiative of all laws; and, in fact, its peculiar and most important function consisted in preparing business for the assembly of the people, where nothing could be proposed which had not previously received the sanction of the council, and where the whole procedure was regulated by functionaries of its appointment. Attendance at the general assemblies was made compulsory on the part of the citizens, and four were held during the presidency of every *Prytaneia*, or term of thirty-five days, for the regular dispatch of public business, which was duly apportioned and subdivided amongst them. The first confirmed or rescinded the appointments of magistrates, received accusations of public offences presented by the *thesmothete* archons, and heard the catalogue of fines and confiscations for the service of the state; the second enacted laws, and disposed of petitions, public and private; the third gave audience to the ministers of foreign powers; and the fourth regulated such matters as concerned religion. All citizens who attended in due time received a small recompense or pay from the treasury. The *Epistates*, chairman, speaker, or president of the assembly, was appointed by lot from the nine *Proedri* or foremen, who were nominated in the same way from the council, that is, one from the counsellors of each tribe whose representatives were not at the time *Prytanes*; and with these functionaries sat the *Nomophylaces*, otherwise called, from their number, The Eleven, whose duty it was to watch over the laws, and to explain to the people the tendency of any proposal which seemed contrary to the spirit of the constitution, as well as to superintend the administration of justice.¹

Annual revision of the laws enjoined. Solon took none of those severe precautions to maintain his constitution which were adopted by some other ancient democratical legislators; neither exacting an oath, like *Lycurgus*, who by a species of artifice sought to render its obligation perpetual, nor ordaining, like *Charondas*, that whosoever proposed to abrogate an old law or enact a new one, should come into the assembly of the people with a halter about his neck. On the contrary, aware that regulations, however well adapted to the circumstances of the commonwealth at one period, might prove wholly unsuitable to its circumstances at another, and that time, the great innovator, rendered certain changes and modifications necessary, he even went so far as to enjoin an annual revision of the laws, and to prescribe the form in which this might with most propriety be effected. If the assembly of the people declared alteration in any point necessary, a committee was to be appointed, with directions to consider the change proper to be made; and if a new

law was in consequence prepared, five officers were at the same time named to defend the old one before the assembly, which then decided between them. The persons composing such a committee were denominated *Nomothetes*, and in later times amounted to so many as a thousand: the persons nominated to defend an old law had the name of *Syndics*. This was the only form in which it was safe, or indeed constitutional, to propose any alteration in the existing law at Athens. But as the passing of a law by the assembly without the regular formalities of previous publication, or of one couched in ambiguous and fallacious terms, or contrary to a former law, subjected the proposer to penalties, it became usual to repeal the old law before any new measure was brought forward; and the delay occasioned by this double procedure served as an additional security to the constitution, which was equally guarded against rash innovation on the one hand, and the danger resulting from the absence of all improvement or amelioration on the other.

The regular and ordinary mode of enacting a law at Athens may be very shortly described. As the council had the initiative of all laws, so it was their duty to frame the bills which were to be submitted to the general assembly of the people. But any citizen having aught to propose for public consideration, might address it to the *Prytanes*, whose duty it was to receive all petitions, suggestions, and communications, and to transmit them to the council. When the matter had been there approved and digested into proper form, it became a *probouleuma* or bill, and being written on a tablet, was exposed during several days for public perusal and consideration. At the next assembly it was read to the people, after which the question was asked by the public crier, "Who of those above fifty years of age chooses to speak?" And these, if any were so disposed, having delivered their sentiments, the crier again proclaimed, "Any Athenian, not disqualified by law, may now speak." The circumstances absolutely disqualifying were flight in battle, a large amount of debt to the commonwealth, and conviction for a crime inferring infamy; but the *Prytanes* had the privilege of enjoining silence at discretion, although the injunction was not effectual unless ratified or acquiesced in by the assembly. When the debates had ended, the suffrages were taken by a show of hands, which was the ordinary way of voting; but in extraordinary cases, particularly where the question to be determined related to alleged mal-administration on the part of magistrates, the votes were given by casting pebbles into vessels prepared for the purpose by the *Prytanes*, who, after the foremen had examined the suffrages, and declared the majority, dismissed the assembly.² Such was the legislative mechanism of the Athenian constitution.

But not satisfied with all these checks and precautions, which seem to have been wisely contrived for steadying the naturally eccentric and irregular movements of a democracy, Solon hoped to provide a further and more powerful restraint against aberration by restoring the Court of *Areiopagus*, improving its regulations, and extending its powers. We have no account of the origin of this celebrated tribunal, which, indeed, the partiality of succeeding ages carried too far back into the fabulous ages to be now discovered. It is certain, however, that the institutions of *Draco* had nearly abolished its authority and superseded its use; and that, at the period of its restoration by Solon, it had sunk into comparative insignificance. By this renowned lawgiver its jurisdiction was revived and greatly extended. It was composed of those who, having executed the office of archon with credit, and passed the

¹ Mitford's *History of Greece*, ubi supra.

² Mitford, ubi supra.

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euthyne or scrutiny concerning their conduct while in power, were considered best qualified, by their experience and integrity, for being admitted members of this tribunal; and, in order to place them above being influenced either by fear or favour, they held their offices not for a year, which was the ordinary official term in the Athenian commonwealth, but for life. The powers of the court of Areiopagus were very great indeed. It is said to have been the first which adjudged the punishment of death for murder; and capital offences amongst the Athenians were for the most part cognizable by it alone. It was the only court from which there lay no appeal to the assembly of the sovereign people. It had power to stay execution of all judicial decrees, not excepting those pronounced by the general assembly itself, and to annul an acquittal or to extend mercy to the condemned; it directed all issues from the public treasury; in its censorial capacity it punished impiety, immorality, and all disorderly conduct, and exercised a general superintendence over the morals and behaviour of the people; it required every citizen to account to it annually for his means of livelihood, and to show that he earned his subsistence by honest industry in his particular calling; lastly, it took a fatherly care of the youth of the republic, and provided that all should receive an education suitable to their rank and fortune. For the dispatch of judicial business the court of Areiopagus sat only during the night, and in perfect darkness, that the members, it is said, might be the less liable to prepossessions either for or against the accused; and, on the same precautionary principle, advocates were required to confine themselves to a simple narrative of facts and statement of the law, without digressing into rhetorical embellishment, or attempting to influence the understandings by appealing to the passions of the judges. In a word, this celebrated institution, which appears to have been of Egyptian origin, and which, after its restoration by Solon, long maintained a high reputation for severe wisdom and strict justice, formed a sort of State Inquisition, and seems to have been organized for the double purpose of checking that constant tendency to excess which is inherent in all purely popular governments, and of maintaining that public and private virtue which has rightly been pronounced the principle of democracy.

Other courts.

Besides the Areiopagus, which ought properly to be regarded as constituting part of the machine of government, there were no less than ten courts of judicature at Athens, of which four had jurisdiction in criminal and six in civil causes. Before the time of Solon the archons officiated as supreme and sole judges in nearly all manner of suits; but these functionaries being appointed by lot, and often very ill qualified for discharging so important a duty, it had become usual for each to choose two persons learned in the law to assist him; and the latter, under the name of *paredri* or assessors, were at length recognised as regular constitutional officers, and appointed with the same formalities as the archons themselves. Solon, however, discerned the inconveniencies of this system, and reformed it altogether. "That," said he, "is, in my opinion, the most perfect government, where an injury to any one is the concern of all." The principle from which he set out was therefore to give to all an immediate concern in the administration of justice. With this view he ordained, that in the courts just mentioned causes should be tried by select bodies of men, resembling modern juries, and called to perform nearly the same functions; the archons merely superintending the preparation of causes, and presiding at the trial of them in the manner of our judges.

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All questions of law or of practice were determinable solely by the latter; but in all questions of fact, or in the general issue of guilty or not guilty, the jury were the exclusive judges; and it was the bounden duty of the presiding magistrate to give immediate effect to their decision, whatever it might be. Any Athenian above thirty years of age, and not under legal disqualification, was eligible as a jurymen, on delivering his name and addition to the thesmothete archons; but as no one could be compelled to serve in this capacity, a small honorarium was given by the treasury to induce such as had leisure to offer themselves.¹ From the general list of those who voluntarily tendered their services, the thesmothete archons appointed by ballot juries to the different courts; and these appear to have officiated for a definite period in each, somewhat in the manner of the Roman *judices*, who were, to all intents and purposes, a species of standing jury. It thus appears that the honour of inventing jury trial is due to the great Athenian lawgiver; and that, in his hands, the institution reached a degree of perfection which it has not yet attained among many modern nations, who affect the greatest admiration for the ancient jurisprudence, and boast of having transfused into their codes its wisest rules and provisions. It is necessary to add, that, in order to save the inhabitants of the country the trouble and expense of resorting to Athens for justice, in cases of inferior importance, itinerant judges, called from their number The Forty, were appointed to make regular circuits through the towns or boroughs of Attica, with full powers to judge and determine in all actions of petty assault, and in all disputes about property under a certain value.

Religion.

In all countries, and throughout all ages, religion and civil government have, with few exceptions, been so intimately, or rather so inseparably connected, that an exposition of the one would be incomplete and even unintelligible without some account of the other. The magistrate has almost everywhere sought the alliance of the priest; and the hopes and fears arising from a supposed dependence on superior power or a belief in a future state of existence have been employed as useful auxiliaries in governing men and managing their affairs in the present life. The possibility of ruling nations by means of their reason alone, and by a due regard to their secular interests, without any reference to their religious opinions or observances, is an idea which seems never to have entered the mind of any ancient legislator, and which even now, when the mighty volume of past experience is unfolded for our instruction, many still consider as little better than downright political heresy. It was deemed alike impious and impracticable to attempt to establish any form of polity of which religion or the church did not constitute one of the main pillars, or to seek to promote the happiness of men in society without at the same time prescribing by law the mode in which they ought to worship the gods. In the Athenian constitution, as settled by Solon, religion and government, the church and the state, were so intimately connected, and became so indissolubly blended together, that, without any sensible error, we may at will consider the religion as part of the government, or the government as part of the religion, and both as alike the creatures of positive enactment or legislative ordination.

A sense of dependence on some superior power is so natural to an imperfect being like man, and has been so universally manifested by him in all the conditions and circumstances under which he is found, that it may be regarded as one of his most prevailing instincts. His own helplessness, compared with the stupendous powers of

¹ Mitford's *History of Greece*, ubi supra.

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nature which he sees constantly in operation around him, necessarily leads the savage to look anxiously for some being of a higher order, on whom to rely for protection against the evils and dangers, real or imaginary, by which he is surrounded; whilst the more enlightened have only to exercise the faculties of their mind in reflecting on themselves, their own relative situation, and the appearances in the world around them, their knowledge and their ignorance, their strength and their weakness, their happiness and their misery, their beginning and their end, in order to be directed to the same belief; coupled with an expectation of some future state of existence, where the inequalities and evils of the present life will be fully redressed, and where ample scope will be afforded for the gratification of those desires and the expansion of those powers which are here confined and repressed. The first suggestions of religion in the human mind, therefore, naturally produce a belief in the existence of a deity, and in the consequent duty of worshipping and serving him. Its primary doctrine is pure, and its primary practice is simple; nor, from the causes which have now been mentioned, can it ever be wholly lost among mankind. But, through the imperfection of human nature, and the debasing alliance of purely human institutions, religion is so prone to degenerate, that superstition in one state of society and scepticism in another, separated perhaps by short intervals of enthusiasm or fanaticism, are almost the only aspects in which history presents it to our view. The variety, indeed, and the grossness, of the corruptions of religion, from which few pages in the annals of the world are pure, may well, as Mr Mitford remarks,¹ excite wonder on first reflection; but if we proceed to inquire into their origin, and to investigate those circumstances in the nature and condition which have combined to produce them, we shall soon find enough to satisfy us that nothing short of a constant miracle could have prevented that degeneracy to which the history of all countries in all ages bears testimony. The fears of ignorance, the follies of wisdom, the interests of cunning, the frauds of priestcraft and statecraft, and even the pride of science, have all and each proved sources of corruption; nor is there almost any human passion which, in one way or other, has not contributed its share to the work of deterioration. Yet, strange to say, this religious debasement has been frequently found co-existent with a high degree of intellectual improvement and an advanced state of civilization.

Source of the Greek superstitions.

The religion, like the science and art of Greece, was not indigenous, but exotic. Derived originally from Egypt, the great storehouse of superstition, it found a congenial soil in the country to which it was transplanted, and in time put forth a multitude of new shoots and branches, worthy of the stock from which they sprung. Its general character and quality, indeed, remained pretty much the same, rationally considered; but many of its harsher peculiarities were mitigated, and as it branched into greater variety, and became more intermixed with the native products of the soil, it lost not a little of the grossness and extravagance for which it had been originally distinguished. In Egypt, where priestcraft formed the inalienable inheritance of a particular order of men or a sacerdotal nobility, who monopolized all learning and all knowledge, superstition naturally presented itself under a hideous and revolting aspect, because the security of this order was incompatible with any condition except that of general debasement. But in Greece, where policy had not made professions and callings hereditary through all ranks of

men, where religion became the ally of free institutions, and where the genius of the people naturally led them to embellish whatever they chose to imitate, the crude and monstrous fictions which had been originally imported from the banks of the Nile were gradually worked up into that graceful though somewhat fantastic and sensual system of mythology which the young are still taught to admire, and which even the old find it difficult to condemn. Among the Greeks, however, as among the Egyptians, two different religions prevailed, both derived from the same source, both acknowledged by the same persons, and both equally warranted by the civil law. But one of these only was common to all the people, revered as the sanction of oaths and obligations, and thus constituted the religion of the state. The other, denominated the mystical, was confined to a select few, who were bound to inviolable secrecy respecting the whole of its doctrines and the greater part of its ceremonies; so that its real character can only be conjectured from the displays made in some public exhibitions, or from casual and scattered hints in the writings of those who had been initiated into its mysteries. The former embraced that system of rites and observances which the legislator and the magistrate publicly recognised and enforced upon grounds of political expediency, and with a view merely to promote the objects and ends of civil government. The latter was in all probability chiefly doctrinal, and confined to those grand elementary principles of natural religion which, as they are the first that present themselves to the human mind, so, without some positive and permanent means of conservation, they are the soonest debased and forgotten; but being rigorously denied to public discussion, and communicable only to the few who had qualified for receiving its esoteric revelations, it had small influence comparatively on public affairs, and in fact is very little noticed by ancient historians.² It is to the exoteric form, therefore, as delivered by Homer, expounded by succeeding writers, and found continually connected with politics, that we shall here direct our attention; promising that a general sketch is all that we intend offering on the subject.

Various are the opinions which have been expressed by Origin of philosophers, and the traditions which have been handed down by poets, respecting the origin of polytheism. Plato, ism. after stating his belief that the host of heaven had originally been the only objects of worship, records a different and very remarkable tradition, according to which "ONE God once governed the universe: but a great and extraordinary change for the worse taking place in the nature of men and things (for originally there was perfect virtue and perfect happiness upon earth), the command then devolved upon Jupiter, with many inferior deities to preside over different departments under him." Here we find the original unity of the deity asserted, and an attempt made to account for the rise of polytheism, on the assumption of a great and deplorable change in human nature and the state of all things upon earth. Plato himself pronounces no opinion on the subject, for the fate of his master Socrates had probably taught him caution; but the notion of such a revolution as that assumed in the tradition which he records was universally entertained, and has been transmitted in a detailed form by Hesiod and other ancient authors; and it is not a little singular that this notion is for the most part combined with an assertion of the unity of the deity. "It is a tradition," says Aristotle, or whoever else was the author of the treatise *On the World*, "received from of old among all men, that God is the creator and preserver

¹ Mitford's *History of Greece*, vol. i. p. 89, et seqq.

² Mitford, *ubi supra*. See also Warburton, *Divine Legation of Moses Demonstrated*, b. iii. On the Myst.

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of all things, and that nothing in nature is sufficient to its own existence without his superintending protection. Hence some of the ancients have held that all things are full of gods, obvious to sight, hearing, and to all the senses; an opinion consonant enough to the power but not to the nature of the deity. God being ONE, has thus received many names, according to the variety of effects of which he is the cause." The testimony of Herodotus is, if possible, still more direct and explicit. After giving an account of the origin of the names of the principal divinities in the Greek Pantheon, he proceeds to say, that, being at Dodona, he was there informed, probably by the priests of the temple of Jupiter, that the Pelasgic ancestors of the Greeks sacrificed and prayed to gods to whom they gave no distinguishing name or appellation, "for they had never heard of any, but called them gods as the disposers and rulers of all things:" from which it appears that the Pelasgians acknowledged but one God; for where polytheism is believed, there will always be a corresponding nomenclature, and it is only the doctrine of the unity of the deity that precludes all use or need of distinguishing appellations.¹

But this purer religion, said to have been brought into Greece by some of its first inhabitants, must have been originally confined to a few, and exposed, from a variety of causes, to speedy corruption and debasement. Its primary doctrines were doubtless preserved in the mystical form which was at a very early period established; but it is inconceivable that, in the popular belief, these could co-exist with the absurdities of polytheism imported from Egypt, and greedily received by the rude natives, in an age when superstition in some form is inseparable from the human mind. Nor, even if the case had been otherwise, is the transition violent from a vague idea of an omnipresent deity to the belief of a separate divine essence in different places and in different things. On the contrary, the superstitions of almost all nations prove it to be congenial to the human mind in its unenlightened state; which, unable to exalt its thoughts to the steady conception of one almighty and boundless being, naturally satisfied itself with ascribing all effects of which it knew not the causes to the immediate presence and agency of distinct powers. But polytheism having been once introduced, soon disseminated itself among a people remarkable for the liveliness of their imaginations as well as for a love of the marvellous; and the Greeks in time far exceeded the bounds of the system which they had derived from their Egyptian instructors. Hence, besides Juno, Vesta, Themis, and others, which they added to the catalogue of the divinities imported from the banks of the Nile, every mountain had its Oread, every wood its Dryad, every fountain its Naiad, every river its god; the sea had its Tritons and its Nereids; the variety of the seasons gave birth to the Hours; and the Muses and the Graces were the immediate offspring of the poetical genius of the people.² In the manufacture of gods unbounded scope was given to the imagination; and thus, even in Homer's time, divinities were so multiplied that nobody any longer cared to say how many there were not. Nor was the balance of power at all well adjusted in the hierarchy of the Greek polytheists. Jupiter, the chief of their gods, was neither omnipotent, nor omnipresent, nor omniscient; and as perfect goodness was nowhere to be found in heaven any more than upon earth, perfect happiness was equally a stranger to its inhabitants. Father Jove himself was supposed to be under the control as well as protection of Fate, which was also personified; and he is described as living under perpetual

apprehension of the inferior deities, as subject to innumerable weaknesses and vices, as liable to be overcome with passion, and as an object of incessant jealousy to his somewhat termagant and unreasonable spouse. Ate, the goddess of mischief, was said to be his eldest daughter; and, probably under her influence, the inferior deities were represented constantly at work to disturb rather than to support or aid the government of their chief. Profligacy, perjury, treachery, sensuality, corruption, and insubordination, were the vices of heaven as well as of earth, and, in point of downright villany and wickedness, the gods, as of right, claimed a marked superiority over men. Such are the representations of poets, and such seems to have been in a greater or less degree the popular belief. But the legislator and the magistrate found it necessary to teach, however inconsistently, that Jupiter would not favour the false; that the gods loved not evil deeds, but honoured justice and the righteous works of men; and that, although the chief of the gods sometimes granted the spoil to hardened and wicked men, the fear of vengeance dwelt on their minds. Religious sanctions were felt to be indispensable for enforcing civil obligations; and gross as were the fictions which composed the body of the popular faith, their aid was sought in maintaining moral and political order, especially as they involved some faint and indistinct notions of future retribution. But how frail that aid really proved, and how much better calculated such a system of religious belief was to subvert than to maintain public or private morality, no one acquainted with the history of Greece need now be told.

At the same time it was a system of show and parade, Genius of of festivals and ceremonies, of rites and observances, and, as such, singularly adapted to take a powerful hold of the popular mind, more especially when it became intimately blended with the literature as well as with the political institutions of the country. It imposed no particular set of doctrines, and exacted no peremptory compliances, but, addressing itself exclusively to the senses and the imagination, it was acquiesced in without inquiry, and maintained without persecution. As the religion of the state, an outward respect was due to it and required; but crimes against this religion were only punished as they affected the state, and not on the abstract grounds of impiety or sacrilege. Socrates was condemned to death, not because he revered the deity and taught a purer faith than that entertained by his countrymen, but because he attacked the religion of the state as by law established, and closely interwoven with the whole system of national policy; and even this sacrifice to the violated law was speedily and deeply repented; for the genius of polytheism was essentially tolerant. Hence mere raillery, when general and not directed against positive institutions, seldom or never incurred the animadversion of the magistrate, and was often highly relished by the people. Aristophanes, for example, made as free with the gods as he did with the great, and lashed the supposed foibles of the former with as little mercy as the vices and follies of the latter; yet his wit produced no inconvenience to its author, and was even loudly applauded by his countrymen. Æschylus, indeed, incurred some danger from a suspicion of having betrayed the secrets of Eleusis; but as this was always considered a crime of the greatest magnitude, and as it imported a violation of the most sacred human obligations, as well as of the public policy of the state in a matter where the sanctions of its laws were peculiarly severe, no inference can justly be drawn from this against the general toleration exercised, viz. when its sallies were directed only against the public religion.

¹ Mitford's *History of Greece*, ubi supra.² *Ibid.*

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Priesthood.

Another circumstance deserving of notice is, that the ministers of religion were not confined exclusively to the service of its altars. The sacerdotal dignity was indeed incompatible with the exercise of any regular profession, and for this reason the priests had a fixed revenue secured to them; but they were eligible to the most important offices in the state, and might, if so inclined, serve as soldiers in the field. Their salaries were in general proportioned to the dignity of their functions and the rank of the deities whom they served; and these were paid out of the sacred revenues, which were derived partly from fines that individuals were condemned to pay for various offences, partly from the produce of lands consecrated to the gods or appropriated to defray the expense of sacrifices offered in the name of the republic, partly from particular grants, and partly from a tithe of the spoils taken in war, although the last were commonly considered the exclusive property of Minerva. These, with the produce of accidental confiscations, formed the regular sources of income; but the credulity of the people supplied an inexhaustible fund, which enriched the temples of Delos and Eleusis, and supported the magnificence and splendour amidst which the Delphic oracle was enshrined. The solemn festivals, such as the Dionysiac and Panathenaic, which indeed constituted the greater part of this religion, and contributed alike to maintain its hold of the popular mind and to nourish a taste for the arts, were celebrated at the expense of the choragi or leaders of the choruses, of which each tribe furnished one; and the richest citizens only were appointed to the office, which, though ruinous, was eagerly solicited, as, like the curule dignity at Rome, it paved the way to more substantial honours, and formed a passport to the favour of a people ever ready to reward him who ministered profusely to their pleasures. *Panem et Circenses!*¹ bread and amusement! may be considered as at once summing up the immediate wants of the sovereign multitude, and pointing out the mode in which wealth might be rendered indirectly subservient to the purposes of ambition. Hence the privilege enjoyed by the choragus who had proved victorious in the scenic contests, of inscribing his name on the tripod erected by his tribe, or of perpetuating the memory of his success by a choragic monument, was not the only recompense looked for by those who had incurred the ruinous expense of ministering to the pleasures of the people. Lastly, although Athens had a state religion, it had no sacerdotal hierarchy. The priests did not, as in Egypt and in other countries, form a distinct order or caste, which, indeed, would have been incompatible with a democratical form of government. They were not a separate body united by peculiar laws under a chief whose authority extended over all its inferior members. The dignity of supreme pontiff was unknown, and each priest served his particular shrine unconnected with his brethren. The temples of the principal divinities, indeed, such as those of Minerva, Neptune, Ceres, and Proserpine, had each a high-priest who presided over its service; and the number of subaltern ministers employed was commonly in proportion to the rank of the particular deity, and the wealth accumulated at his shrine: but the pontifical dignity was altogether local; and the priests of one temple formed a society wholly distinct from those of another. Hence the ministers of the gods at Athens were not judges in matters of religion, nor authorized to take cognizance of or to punish crimes against the deity. This, as we have already said, was exclusively within the competency of the civil magistrate; and,

accordingly, we find that it was in consequence of a civil sentence alone, and not in virtue of any power or authority in themselves, that the Eumolpidae launched their anathemas against Alcibiades, and that Socrates was adjudged to die the death.

The subject of the public economy of the Athenian state, embracing inquiries concerning prices, wages, and the interest of money; the administration of finance and the public expenditure; the ordinary and extraordinary revenues; and the peculiar financial measures of the Greeks; is too vast and complicated to be treated here at full length. In Boeckh's learned and laborious work, however, there will be found a prodigious accumulation of curious facts relative to all these branches of the subject; and although the science of the author is greatly inferior to his erudition, and his conclusions are frequently at variance with sound principle, yet he has furnished abundant means for the correction of his own errors, and collected a body of information, the value and importance of which it is difficult to overestimate. A large part of his first book is dedicated to an enumeration of the various prices of commodities in Attica, by comparing which with the actual prices of the same commodities in different countries, he endeavours to determine the relative wealth of Attica according to modern standards. But although this collection is equally interesting and valuable, the utility of such a comparison may be fairly questioned, upon the ground that no certain inference can be drawn from the similarity or dissimilarity of ancient and modern prices. The proportion between the value of any given commodity and that of gold or silver may be a safe enough criterion in the same place and for short periods of time; but for distant ages and countries such a comparison can lead to no result upon which any reliance can be placed; and for this plain reason, that we have no common or invariable standard to which we can refer. For a comparison with prices in other countries at the same time, and for such a purpose as that to which Boeckh has applied it in examining the statement of Polybius respecting the valuation of Attica, his list of prices may be used with safety and advantage; but whether the precious metals, labour, or any other standard, be adopted as a medium of comparison between the prices of commodities in ancient Greece and in modern Europe, the result must, for the reason already stated, be equally fallacious and nugatory. The standard employed, whatever it may be, is itself indeterminate; or, in other words, the measure assumed and the thing to be measured by it are equally uncertain.

Again, with regard to the interest of money, it is evident that no sound conclusion can be drawn as to its rate from a consideration of the *ναυτικός τόκος* or interest of money lent on bottomry, which Boeckh takes as a criterion; because this was doubtless a most hazardous species of investment, on account of the imperfect state of nautical science, the dangerous navigation of the Greek seas, and, worse than all, the insecurity of the laws and the corruption of the tribunals; and the premium paid by the borrower to the lender would of course be in some measure commensurate with the risk to which the capital of the latter was exposed. Nor is this all. For, if the rate of interest be that sum which the lender receives and the borrower pays for the use of a certain amount of monied capital, without any consideration for trouble in the collection of the income, or for risk as to the punctual repayment of the interest or principal at stipulated periods, it may fairly be doubted whether there was any thing

¹ *Pan y toros!* Bread and bulls! exclaims the philosopher Jovellanos, who, in lamenting the fallen and degraded state of his countrymen the Spaniards, unconsciously parodies the expression employed on a similar occasion by an old Roman, at once indignant and sorrowful at the degeneracy that surrounded him.

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which can justly be considered as a general or an established rate of interest at Athens. There were no public securities, no means of investing money under the guarantee of the national credit; whilst, from the continual dread of revolution or foreign invasion, the insecurity of property was such that the punctual repayment of interest or principal at stipulated periods must have been liable to very great, but at the same time very variable, risks; a state of things wholly incompatible with a general or an established rate of interest. And with respect to money lent on mortgage or land-pledge, which in the settled communities of modern times approaches nearest to the public securities in point of safety, the tenure of land in Attica was, from the causes already mentioned, so precarious and insecure that, in this case also, a large yet variable indemnification, in the name of interest, must have been paid, and consequently no particular rate could have been general or common.

Revenue.

Mr Mitford has been led to accuse the Athenian state of neglect in the administration of its finances, but without reason, as Boeckh has most conclusively shown. Of all charges, indeed, the government of Athens is the least open to that of want of diligence in exacting the utmost farthing of revenue which its available resources could by any artifice of taxation be made to afford. The ordinary revenues of the Athenian state consisted chiefly of duties arising from lands, houses, and similar property of the state, or from companies and temples; of the produce of the mines, which were public property, though commonly let in fee-farm under certain conditions, including the payment of a twenty-fourth part of the gross produce in the name of rent, and over and above the grassum or fine which the tenant originally paid for the lease; of custom-house duties; of harbour duties and market tolls; of tithes, poll-taxes, taxes upon industry, protection-money, taxes on slaves, and taxes on prostitutes; of judicial fines and fees; of appeal-money, and fines in general; of confiscations, and tribute of various kinds; to say nothing of a variety of minor sources which it would be tedious to enumerate. The extraordinary revenues were of course variable, but arose principally from a species of property-tax, which was laid on in seasons of great emergency, when increased means were required for the defence of the state, or for the assertion of its dignity and independence. The spoils of war were also included under this head.

Property of all kinds appears to have been commonly let upon lease; and all leases were sold by auction to the highest bidder. For this purpose the conditions of lease were previously engraved upon stone and fixed up in public. The names of the lessees were subsequently added, and the document which had been originally exhibited then became a regular contract of lease; or if not, a fresh agreement was afterwards set up. A proposal or advertisement of this kind, copied from the original document engraved on stone, and still extant, being preserved in the British Museum, is to the following effect:—"In the archonship of Archippus, Phrynon being demarch. The Peiræans let Paralia, and Halmyris, and the Theseium, and all the other sacred lands, upon the following conditions: That the tenants for more than ten drachmas are to give sufficient security for the payment of the rent; and that those for less than ten drachmas are to provide a surety, whose property shall be liable for the same. Upon these conditions they let the lands, tax and duty free. And if any property-tax be imposed upon the farms according to their valuation, the burghers will pay it. The tenants shall not be allowed to remove wood or earth from the Theseium and other sacred lands, nor injure whatever wood there is on the farm. The tenants of the Thesmophorium, and the Schœnus, and the other pasture-lands, shall pay half the rent in Hecatombeon (the first month) and the other half in Poseidon (the sixth month). The tenants occupying Paralia, and Halmyris, and the Theseium, and any other grounds that there may be, shall cultivate them for the first nine years in whatever manner they please, and according to custom; but in the tenth year they shall plough the half of the land, and no more, so that the succeeding tenant may be able to begin preparing the soil from the sixteenth of Anthesterion. And if he shall plough more than half, the excess of the produce shall be the property of the burghers."¹ Then follows a stipulation that the tenant shall receive a house connected with one of the farms, in good repair. This document, which is in several respects a remarkable one, shows that the public economy of Athens, in as far as concerns the law of landlord and tenant, had attained considerable advancement, and that the state had not been wanting in a due regard to the security as well as the improvement of property. (A.)

Attica.

Mode of letting property.

ATTICUS, TITUS POMPONIUS, one of the most distinguished men in ancient Rome. He understood so thoroughly the art of conducting himself with address, that without in any degree compromising his neutrality, he preserved the esteem and affection of all parties. His strict friendship with Cicero did not prevent him from being at the same time on terms of great intimacy with Hortensius. The contests at Rome between Cinna's party and that of Marius induced him to retire to Athens, where he continued for a considerable time. Atticus was much attached to polite

learning, and kept constantly employed at his house several librarians and readers. He might have obtained the most considerable offices in the government; but he chose rather not to interfere, because amidst the corruption and faction which then prevailed he could not discharge the duties connected with them according to the laws. He wrote *Annals*, or *Universal History*, embracing (as we learn from Cicero) a period of 700 years; and some other pieces, of which none has been preserved. He married his daughter to Agrippa. Having reached the seventy-seventh year of his age,

¹ This inscription was first published by Chandler from a most inaccurate transcript, together with a Latin version, also very indifferently executed. It was afterwards given by Boeckh, in the appendix to his *Staatshaushaltung der Athener*, where he corrected many of Chandler's errors; and he has since repeated it with some additional improvements in his collection of Greek Inscriptions, p. 141. It consists of twenty-three lines without the date, which is written in larger characters upon a projecting ledge of the stone, and, with the final corrections of the English translator of Boeckh, is as follows:—

Επι Αρχιππου αρχοντος, Φρυνιωνος δημαρχου.

Κατα ταδε μισθουσιν Πειραιεις Παραλιαν και 'Αλμυριδα και το Θησιον και τ' αλλα τιμυνα ἅπαντα* τους μισθωσαμενους ὑπερ : Δ : δραχμας καθισταναι αποτημημα της μισθωσης αξιοχρεων, τους δε εντος Δ δραχμων εγγυητην αποδοιδμενον τα ιαυτου της μισθωσης. Επι τεισδε μισθουσιν ανεπιτιμητα και ατιλη. Εαν δε τις εισφορα γινηται απο των χωριων του τιμηματος, τους δημοτας εισφειν την δε ὕλην και την γην μη εξιστω εξαγειν τους μισθωσαμενους μητε εκ του Θησιου μητε εκ των αλλων τιμινων* μητε την ὕλην... ὁση τῶ χωριῶ. Οἱ μισθωσαμενοι το Θισμοφοριον και το του Σχοινοντος και τ' αλλα εννομια την μισθωσιν καταθησουςι, την μιν ἡμισιαν εν τῶ 'Εκατομβαιονι την δε ἡμισιαν εν τῶ Ποσειδωνι. Οἱ μισθωσαμενοι Παραλιαν και 'Αλμυριδα και το Θησιον και τ' αλλα ει που τι εστι, ὅσα οἶον τε και θεμιτον εστιν εργασιμα ποιειν, κατα ταδε εργασσονται, τα μιν εννια ετη ὅπως αν βουλωνται, τῶ δε δικατῶ ετι την ἡμισιαν αρουν και μη πλειω, ὅπως αν τῶ μισθωσαμενῶ μετα ταυτα εἴη ὑπεργαζισθαι απο της ἱκτης επι δικά του Ανδιστηριωνος* εαν δε πλειω αροση η την ἡμισιαν, των δημοτων εστω ὁ καρπος ὁ πλειων* την οικιαν την εν 'Αλμυριδι στιγουσαν παραλαβων και ορθην κατα την συνθηκην. Πασαι δε αἱ οικiai παραδιδοςθων ορθαι.

The date, mutilated at the end, is either Olymp. 114. 4, or 115. 3.

Attigny he was seized with an incurable disorder; and his case being considered hopeless, he anticipated the consummation of the disease, by abstaining from food, in consequence of which he died upon the fifth day, B. C. 33.

ATTIGNY, a small town of France, in the department of Ardennes. It was a place of some celebrity at an early period, from its being usually selected as the summer residence of the kings of France. It is situated on the river Aione, in long. 4. 47. E. lat. 49. 30. N.

ATTILA, king of the Huns, surnamed *the Scourge of God*, may be ranked amongst the greatest and fiercest of conquerors, since there was scarcely any province of Europe which did not feel the weight of his victorious arms. His death was attended with singular circumstances. He had married a beautiful virgin named Ildico. His nuptials were celebrated with great festivity at his palace beyond the Danube, and he retired late to bed oppressed with wine. In the night a blood-vessel burst in his lungs, and suffocated him. The bride was found in the morning sitting by the bedside, lamenting his death and her own danger. The body, inclosed in three coffins, of gold, silver, and iron, was interred in the night time; and to prevent the violation of his remains by the discovery of the place where he had been buried, all the captive slaves employed in the solemnity were massacred. This happened about the year 453. With Attila ended the empire of the Huns. His sons, by dissension and civil war, destroyed one another, or were dispossessed by more powerful chieftains.

ATTLEBOROUGH, or ATTLEBURGH, a market-town of the hundred of Shropham, in the county of Norfolk, ninety-three miles from London, and six from Norwich. This place is said to have been formerly a large city, the capital of the county, and at one time had a collegiate church. There is a market held every Thursday, and another every alternate Tuesday. The population in 1801 was 1333; in 1811, 1492; and in 1821, 1659.

ATTLEBURY, a town in the county of Norfolk in England. Long. 0. 40. E. Lat. 52. 23. N.

ATTOCK, a celebrated town and fort of Hindostan, in the province of Lahore, situated on the eastern bank of the Indus, which is here from three fourths to one mile across. It is the place where Alexander, Tamerlane, and Nadir Shah crossed the river in advancing eastward into India. The emperor Akbar built the present fortress in 1581. The fortress still retains the ancient name of Varanas or Benares, though it is more generally known by that of Attock. Long. 71. 15. E. Lat. 33. 6. N.

ATTORNEY AT LAW answers to the procurator or proctor of the civilians and canonists. He is one who is put in the place, stead, or room of another, to manage his matters of law.

ATTORNEY-GENERAL, a great law-officer under the king, whose duty it is to exhibit informations, and prosecute for the crown, in matters criminal, and to file bills in the exchequer for any thing concerning the king in inheritance or profits.

ATTRACTION.

THE word Attraction is used to denote what we observe when one body approaches another, or tends to approach it, without any apparent impulse or other cause to which the motion can be ascribed.

We have instances of attraction when iron approaches the magnet, when certain bodies are placed near an excited electric, and when a stone falls to the earth. We say likewise that the earth attracts the moon; by this mode of expression meaning no more than that the moon is continually deflected towards the earth, from the rectilinear course which it would otherwise pursue. It is likewise in this sense that we must be understood when we say that the sun attracts all the planets.

In the instances already mentioned, attraction extends to a distance. In other cases it is confined within limits so extremely narrow as to become imperceptible at an interval which cannot be appreciated by the senses. Of this kind is the attraction which takes place between the particles of the same fluid, as is apparent from the round figure of small drops. To this class likewise belongs the attraction between fluid and solid bodies; whence originate the very interesting appearances observed in capillary tubes, and other kindred phenomena. An attraction between the small elementary particles of all solid bodies is manifest from the force with which they cohere or resist an endeavour to separate them. In many cases the intensity of this force is prodigiously great in contact or at the nearest distances; while it ceases to act upon making the smallest separation between the parts. Lastly, chemistry develops innumerable instances of attraction between the molecules of the bodies about which it is conversant; insomuch that it is to this principle, under the name of affinity, that we must ultimately ascribe the various decompositions and new combinations which occur in that science.

All these phenomena, although very different from one another in other respects, have yet this in common, that

we observe in certain bodies a tendency to approach one another, and to resist a separation, with some degree of force. The facts are certain, and are attended with no ambiguity; and it is to express these facts that the term *attraction* is used in physics.

We likewise observe, in some bodies, a tendency to fly off from one another when they are brought near. This is called *repulsion*.

The word *force* has, in general, some degree of obscurity. It is used to denote the cause of motion; but we have no direct knowledge of it, and we judge of its intensity by the effect which we suppose it to produce. In all our reasoning concerning forces, it is the changes of motion which we measure and compare together, and which are really the subjects of our thoughts. Attraction and repulsion are forces or principles of motion, known to us only by the phenomena we observe; but the circumstance of their implying action at a distance is an additional source of obscurity in which other kinds of force do not participate.

It certainly is inconceivable that motion should be produced at a distance, when no connection can be traced between the body moved and that which is supposed to produce the motion. We are strongly impressed with the prejudice, that a body cannot act but where it is; and we find difficulty in admitting that the mere presence of two bodies, without the intervention of any mechanical means, can be a satisfactory cause of motion. On this account attraction has been classed by some with the occult qualities of the schools; and the favourers of this doctrine have been reproached with reviving exploded notions in philosophy. Impulse is a principle of motion more familiar to us, and to which we are not disposed to make equal objection. Whenever the communication of motion can be traced to this source, we are satisfied that the effect is justly explained. Hence many philosophers have been of opinion, that impulse is the only cause of motion that can

General observations.

Attleborough
||
Attraction.

Attraction. be admitted in physical science; and many attempts have accordingly been made to reduce to this principle all cases in which distant bodies act on one another. With regard to these attempts, it will be sufficient to remark here, that they are all built upon hypothesis. No evidence is adduced to prove that such things exist as the elastic ether or gravific matter which they set out with supposing. And, as far as such systems have no other object than to obviate the difficulty of action at a distance, this argument alone is sufficient to confute them, without adverting to the difficulties that attend each of them separately, their inconsistency with the received laws of motion, and the innumerable contradictions and improbabilities to which they are liable on every side.

A little reflection is sufficient to show that, in reality, we have no clearer notion of impulse as the cause of motion than we have of attraction. We can as little give a satisfactory reason why motion should pass out of one body into another on their contact, as we can, why one body should begin to move, or have its motion increased, when it is placed near another body. It is equally impossible in both cases to prove that there is a necessary connection between the related facts; and in this respect both the phenomena are alike inexplicable.

When motion is produced by impulse, it is probably the circumstance of contact apparently taking place which leads us to think that the effect is so clearly explained. It is in this manner only, or by actual contact, that we ourselves can move external objects. We have no power of producing motion in distant bodies, except by the intervention of other bodies on which we act immediately. Impulse is, therefore, a cause of motion familiar to us, and strikes us as the plainest and most satisfactory ultimate principle at which we can arrive. On the other hand, when one body attracts another at a distance, there is nothing familiar to us with which we can compare it; our curiosity is excited, and we are led to seek out some hidden connection between them.

But it may be doubted whether there is actual contact in any case of the communication of motion. When a body is impelled by the air, it will hardly be affirmed that the particles of that elastic fluid are in contact with one another, since there is no space, however small, within which a given bulk of it may not be compressed, by applying an external force sufficiently great. The particles of air, therefore, act on one another at a distance; and the same thing must be true of all other elastic fluids. And, by the way, what is here said is sufficient to prove, that no scheme, founded on the hypothesis of an elastic ether, will enable us to account for attraction; because such a contrivance can do nothing more than substitute one species of action at a distance instead of another. There is good reason to think that absolute contact never takes place in the component parts of the hardest and most compact solid bodies. This seems to be an unavoidable consequence of the fact, well established by experience, that all bodies contract in their bulk by cold, and expand by heat. It is therefore not only not impossible, but it is even in some degree probable, that the communication of motion may, in every instance, be a case of action at a distance.

If, then, we are apt to think that impulse is a clearer physical principle than attraction, there is in reality no good ground for the distinction; it has its origin in prejudice, and in our mistaking the proper object of natural philosophy. All our researches in nature are confined to the phenomena we observe, and to the laws by which they are regulated. A physical cause is no other than a general fact discovered by a careful observation and an attentive comparison of many particular and sub-

ordinate facts. We have no evidence, independent of experience, that any consequence, deduced from a physical cause, will actually take place. There is in this case no necessary connection from which we can, with absolute certainty, infer the expected event. If, then, we regard impulse and attraction as principles founded in fact, and regulated by laws confirmed by observation and experiment, they are both equally entitled to be classed as physical causes, and they ought both to be admitted as of equal authority in explaining the phenomena of the universe.

If we turn our attention to the different kinds of attraction enumerated above, and inquire what progress has been made in the investigation of their laws of action, we shall find that, generally speaking, this branch of physics has been little advanced. We are very imperfectly acquainted with magnetical and electrical attraction. We know still less of those attractive powers which take place at small distances, and which are confined within such narrow limits that their mode of action escapes the observation of our senses. Attraction is, indeed, much used by philosophers to account for many important natural phenomena; but their explanations are often vague, and destitute of that precision which ought always to be aimed at in physical science. There is only one class of phenomena in which the laws of attraction have been fully developed. We allude to gravitation, that principle which occasions the fall of heavy bodies at the surface of the earth, and which retains the planets and comets in their orbits. Referring the other species of attraction, which are little susceptible of general discussion, to their several heads, we shall now confine our attention to gravitation.

Traces of the principle of gravitation are to be found in writers of great antiquity; but their speculations on this subject do not go beyond a vague notion of a tendency which the planets have to one another, or to a common centre. It would contribute little either to entertainment or instruction to collect all the passages of ancient authors that speak of this principle. The revival of the true system of the world by Copernicus introduced the most admirable simplicity in the explanation of the planetary motions, and likewise led to more just conjectures concerning the laws by which they are upheld. Copernicus himself attributed the round figure of the planets to a tendency which their parts possess of uniting with one another, thus extending to all the planets that attraction which we observe at the surface of the earth. He stopt short indeed at this point, conceiving attraction to be confined to the matter of each planet, without making it extend from one planet to another, so as to actuate all the bodies of the system. This step was made by the bold and systematic genius of Kepler. Adopting the opinion of Dr Gilbert of Colchester, that the earth is a great magnet, Kepler formed to himself a notion of attraction, in some respects remarkably just. He says that the earth and moon attract one another, and, were it not for some powers which retain them in their orbits, they would move towards one another, and would meet in their common centre of gravity. He attributes the tide to the moon's attraction (*virtus tractoria quæ in luna est*), which heaps up the waters of the ocean immediately under her. But in many respects his notions of attraction were fanciful and extravagant; a more perfect knowledge of the laws of motion than had been attained to in his time, and a new geometry, were both wanting in order to guide him in this research without danger of wandering. Yet he was able to penetrate so far into the causes of the planetary motions, as to foresee that they would not long continue latent; and he tells us, he was persuaded that "the full discovery of those mysteries was reserved for the next age, when God

Discovery of the law of gravitation.

Attraction. would reveal them." So full an exposition of a physical system of the world as is contained in the writings of Kepler could not fail to draw the attention of succeeding philosophers. Many remarks concerning the principle of gravitation are to be found in the writings of Fermat, Roberval, Borelli, and other authors; but no one before Newton entertained so clear and systematic a view of the doctrine of universal gravitation as Dr Robert Hooke. In his work on the motion of the earth, published in 1674, twelve years before the appearance of Newton's *Principia*, he lays down these three positions as the foundations of his system, viz.:—

"1st, That all the heavenly bodies have not only a gravitation of their parts to their own proper centre, but likewise that they mutually attract each other within their spheres of action.

"2dly, That all bodies having a simple motion will continue to move in a straight line, unless continually deflected from it by some extraneous force, causing them to describe a circle, or an ellipse, or some other curve.

"3dly, This attraction is so much the greater as the bodies are nearer."

The principle of universal gravitation is here very precisely enunciated. Dr Hooke seems to have clearly perceived that the planetary motions are the result of an attraction towards the sun, and of a rectilinear motion produced by a projectile force. Not having discovered the law according to which the force diminishes as the distance from the sun increases, he contrived experiments to elucidate his theory. Having suspended a ball by means of a long thread, he placed another ball upon a table immediately under the point of suspension, and he caused the suspended ball to revolve round the stationary one. When the movable ball was pushed laterally with a force properly adjusted to its deviation from the perpendicular, it described an exact circle round the ball on the table: in other cases it described an ellipse, or an oval resembling an ellipse, having the other ball in the centre. Dr Hooke observed, that although this experiment in some measure illustrated the planetary motions, yet it did not represent them accurately; because the ellipses which the planets describe have the sun placed in one focus, and not in the centre. Thus, at the appearance of Newton, many things were known, or rather surmised, that prepared the way for the discovery of the principle which regulates the celestial motions. This does not detract in any degree from the glory of Newton, who, discarding the conjectures of his predecessors, proposed to himself to investigate, with mathematical strictness, the law of the attractive force, and to ascertain with precision its sufficiency to retain the planets in their orbits. He invented a new kind of geometry, which was necessary to enable him to accomplish his purpose. With this help, and by admitting nothing without the sanction of the established principles of Dynamics, he deduced from the motions of the celestial bodies the law of universal gravitation, the most important and the most general truth hitherto discovered by the industry and the sagacity of man, viz. "that all the particles of matter attract one another, directly as their masses, and inversely as the squares of their distances."

Having arrived at a principle which belongs to every part of matter, another inquiry comes into view. Setting out from this principle, it is now necessary to proceed in an inverted order, and deduce from it, by synthetical reasoning, the phenomena which we observe in the universe. The first step in this process is to find out the attractive force of the planets, which arises from the united attractions of their component parts. Two things only are involved in this investigation, viz. the known law of attraction between the particles of matter, and the

figure of the attracting bodies. This is a subject of great importance, and it is connected with some principal points of the system of the world, with the theory of the figure of the planets, that of the tides, and many other phenomena. It is but imperfectly discussed in Newton's immortal work; and there is no part of his philosophy which has been improved more slowly by the labours of his followers. We now propose to treat of it at some length, endeavouring to lay before our readers as complete a view of this part of science as the nature of our work will permit.

We begin with laying down some definitions, and demonstrating some properties, of elliptical spheroids.

Def. 1. A solid generated by the revolving of an ellipse about either axis is called a spheroid of revolution. If the ellipse revolve about the less axis, the spheroid is oblate; if about the greater axis, it is oblong.

Let k and k' denote the two axes of the spheroid, k being that of revolution; and let x and y be two co-ordinates of a point in the surface of the spheroid, having their origin in the centre, x being parallel to the axis of revolution, and y perpendicular to it; then the equation of the spheroid, whether oblate or oblong, will be $\frac{x^2}{k^2} + \frac{y^2}{k'^2} = 1$.

Def. 2. An elliptical spheroid, in general, or an ellipsoid, is a solid bounded by a finite surface of the second order. Let ACB and ADE (Plate CII. fig. 1: this figure represents one eighth of an ellipsoid contained in one of the solid angles formed by the three principal sections) be two ellipses that have the same axis AO, the same centre O, and their planes perpendicular to one another: from any point K in the common axis, let there be drawn ordinates in both ellipses, as KC and KD; then, having described an ellipse of which KC and KD are the semiaxes, the periphery DMC of that ellipse will be in the surface of the ellipsoid. This solid figure has a centre, three axes crossing one another at right angles in the centre, and three principal sections made by planes passing through every two of its axes.

Let k, k', k'' denote the three semiaxes, viz. $k = OB, k' = OE, k'' = OA$; and let x, y, z , denote three rectangular co-ordinates of a point M in the surface, the co-ordinates being parallel to the axes, and having their origin in the centre, viz. $MN = x, NK = y$, and $OK = z$; then the equation of the surface will be $\frac{x^2}{k^2} + \frac{y^2}{k'^2} + \frac{z^2}{k''^2} = 1$; as it is easy to prove from the foregoing construction.

The ellipsoid becomes a sphere when all the three axes are equal: it becomes a spheroid of revolution when two of them are equal.

1. If any plane cut an elliptical spheroid, the section will be an ellipse. In the spheroid of revolution, a section made by a plane perpendicular to the axis of revolution is a circle. All this follows so easily from the nature of the solids, that we need not stop to give a formal demonstration.

2. If a straight line cut two concentric ellipses that are similar and similarly situated, the parts of it between the outer and inner peripheries are equal to one another.

Let AHBK and MDNC (Plate CII. fig. 2) be two similar and similarly situated ellipses that have the same centre O; and let the straight line AB cut them both; then AC and BD are equal. Bisect CD in L, and through L and the common centre draw the straight line HMNK to cut both ellipses. Because the ellipses are similar and similarly situated, and that CD is an ordinate of the diameter MN, it is plain that AB will be an ordinate of the diameter HK; wherefore, AB and CD being both bisected in L, AC is equal to BD.

Attraction. 3. *If there be two ellipses, one within the other, such that, any straight line being drawn to cut them, the parts of it between their peripheries are equal to one another, these ellipses are concentric, similar, and similarly situated.*

Let D (fig. 2) be any point in the inner ellipse, and through D draw EF, terminating in the outer ellipse: then, if we make $FG = DE$, G must be a point in the inner ellipse. Hence all the points of the inner curve are determined when the outer ellipse and the point D are given: wherefore there cannot be two different curves, both passing through D, that will answer the conditions. But an ellipse described through D, concentric with the outer ellipse, and similar to it, and similarly situated, will answer the conditions (2). Wherefore the two ellipses are concentric, and similar, and similarly situated.

4. *If a straight line be drawn to cut two elliptical spheroids that have the same centre, and are similar and similarly situated, the part of it between the outer and inner surfaces will be equal to one another.*

Conceive a plane, which contains the straight line, to pass through the common centre of the solids: the sections made by the plane will be concentric ellipses (1); and these will be similar and similarly situated, because the solids are so: wherefore the parts of the straight line between the surfaces are equal (2).

5. *If two elliptical spheroids that have the same centre, and are similar and similarly situated, be cut by a plane, the two sections will be concentric ellipses that are similar and similarly situated.*

For the sections are ellipses (1); and, any straight line being drawn to cut them, the parts of it between the peripheries will be equal (4). Wherefore the ellipses are concentric, similar, and similarly situated (3).

6. *Let ADE and CFG (fig. 3) be two concentric ellipses that are similar and similarly situated; let AO and CO, in the same straight line, be two of their axes, and let DE, drawn through C, be perpendicular to AO; then if CF and CG be two chords of the interior ellipse that make equal angles with the axis CO, and if the chords DM and DN of the exterior ellipse be drawn respectively parallel to CF and CG; the sum of CF and CG will be equal to the sum or difference of DM and DN, according as they both fall on the same side, or on different sides of DE.*

For draw EP parallel to CF, and it will likewise be parallel to DM. Because CF and CG are equally inclined to CO and to DE, it is plain that DN and EP, which are parallel to CF and CG, are likewise equally inclined to DE: consequently $DN = EP$. Draw a straight line through the common centre to bisect DM in L, and that straight line will likewise bisect EP, parallel to DM, in H: and because the ellipses are similar and similarly situated, the same straight line will likewise bisect the chord CF of the interior ellipse, in K. Because $DC = CE$, therefore $DL + EH = 2CK = CF$. Wherefore $DM + DN = 2DL + 2EH = 2CF = CF + CG$.

The demonstration of the other case, when DM and DN fall on different sides of DE, is entirely similar.

Some general Properties, resulting from the Law of Attraction that obtains in Nature.

7. *Let AB and EF (fig. 4) be two indefinitely slender pyramids, that are similar to one another, and both composed of the same homogeneous matter, which attracts in the inverse proportion of the square of the distance: the attractions of the pyramids upon particles placed at the vertices A and E are proportional to the length of the pyramids.*

Conceive each of the pyramids to be divided into an indefinitely great number of thin slices of equal thickness, by planes parallel to its base; then, if CD and GH be any two of these slices, their attractions upon particles placed

at A and E will be proportional to $\frac{CD}{AC}$, and $\frac{GH}{EG}$: Now, Attraction.

these are equal; for the solids CD and GH having the same thickness, they are proportional to the sections CM and GN, that is, to AC^2 and EG^2 , because the pyramids are similar. Wherefore the attraction of any one of the slices in the pyramid AB, upon a particle placed at A, is equal to the attraction of any one of the slices in EF upon a particle placed at E. Consequently, the whole attraction of the pyramid AB is to the whole attraction of the pyramid EF as the number of slices in AB to the number of slices in EF, that is, as the length AB to the length EF.

Cor. 1. The attractions of any portions of the pyramid are as the lengths of the portions. For the attractions are proportional to the number of slices in the portions, that is, as the lengths.

Cor. 2. If the pyramids have different densities, their attractions are proportional to the lengths multiplied by the densities. For, in this case, the attraction of each slice will be proportional to its density; wherefore the attractions will be as the densities multiplied by the number of slices, or as the densities multiplied by the lengths.

8. *If there be two similar solids composed of the same homogeneous matter, which attracts in the inverse proportion of the square of the distance; any two particles of matter, similarly situated with regard to the solids, will be attracted by them with forces that are proportional to any of the homologous lines of the solids.*

Because the solids are similar, they may be resolved into an indefinitely great number of slender pyramids, and frustums of pyramids, that are similar to one another, and similarly placed in the solids; each pyramid having its vertex at one of the attracted particles. The direct attractions of any corresponding pair of pyramids will have constantly the same ratio to one another; for they will be as the lengths of the pyramids or frustums (7); that is, because the solids are similar, as any two homologous lines of the solids. Wherefore the whole attractive forces, compounded of all the direct attractions which act in directions that make the same angles with one another, will likewise have to one another the proportion of any two of the homologous lines of the solids.

Cor. If the two solids have different densities, their attractions will be proportional to the densities multiplied by any homologous lines of the solids (7, Cor. 2).

9. *If there be two concentric elliptical spheroids that are similar and similarly situated, a particle placed anywhere within the inner surface will be in equilibrium, or will be urged equally in all opposite directions by the shell of homogeneous matter contained between the two surfaces, supposing the law of attraction to be that of the inverse proportion of the square of the distance.*

Let P (Plate CII. fig. 5) be a particle placed within such a shell, and let a slender double pyramid, having P for the common vertex, be extended to meet the surfaces of the solid on both sides of P. The portions of the pyramid AGHB and CEFD between the surfaces on opposite sides of P, will have equal lengths (4); wherefore these portions will attract a particle placed at P with equal forces (7, Cor. 1). The same thing may be proved of all the pyramids which have their vertices at P, and fill the spheroids. Wherefore P is attracted equally in all opposite directions by the homogeneous matter contained between the surfaces of the spheroids.

10. *To find the attractive force of an indefinitely slender prism, acting in a direction parallel to the prism, upon a particle of matter placed anywhere.*

Let BC (Plate CII. fig. 6) be a prism of homogeneous matter, upon the indefinitely slender base CH, and

Attraction. let a particle of matter be placed at A; draw AB and AC to the extremities of the prism, and AE to any point in it; and draw AD perpendicular to BC. Let S = base CH, and put AD = a, DE = x; the element of the prism is = S × dx, the element of the attraction in the direction AE is = $\frac{S \times dx}{AE^2}$, and the element of the attraction

in the direction parallel to the prism is = $\frac{S \times dx}{AE^2}$

$$\times \frac{DE}{AE} = \frac{S \times x dx}{(a^2 + x^2)^{\frac{3}{2}}}.$$

$$\text{Now, } \int \frac{S \times x dx}{(a^2 + x^2)^{\frac{3}{2}}} = \text{Const.} - \frac{S}{\sqrt{a^2 + x^2}} = \text{Const.} - \frac{S}{AE};$$

and the constant quantity is determined by making the fluent begin at the end of the prism nearer to A; wherefore the whole attractive force of the prism, in the direction parallel to the prism, is

$$= S \times \left\{ \frac{1}{AB} - \frac{1}{AC} \right\}.$$

Cor. In like manner may the attractive force of the prism be found, when the attraction of the particles is proportional to any function of the distance.

Let AB = f, AC = f'; suppose that φ(f) is the function of the distance that expresses the law of attraction; and put ∫df · φ(f) = Ψ(f); then the attraction parallel to the prism is

$$= S \times \pm [\Psi(f) - \Psi(f')],$$

observing that the attraction is always positive.

ATTRACTION OF SPHERES.

Attraction of spheres. 11. Spheres of the same homogeneous matter attract particles placed on their surfaces with forces proportional to their radii.

Spheres being similar solid figures, this proposition is no more than a particular case of what was before proved (8).

Cor. If the spheres have different densities, the attractions at their surfaces are proportional to their radii multiplied by their densities. (8, Cor.)

12. The force with which a particle, placed anywhere within a sphere of homogeneous matter, is urged towards the centre, is proportional to its distance from the centre.

Conceive a concentric sphere to be described, which contains the attracted particle in its surface; the matter between the two surfaces will exert no force on the particle (9), which will therefore be urged to the centre, only by the attraction of the inner sphere, in the surface of which it is placed; but this force is proportional to the radius of the sphere, or to the distance of the particle from the centre (11).

13. Let PNQ and ABC (fig. 7) be two spheres of the same homogeneous matter, which attracts in the inverse proportion of the square of the distance; let the centres of the spheres be at M and D, and take MR equal to the radius of the sphere ABC, and ED equal to the radius of the sphere PNQ; the attractions of the spheres upon particles placed at R and E are to one another as the squares of the radii of the spheres.

In the spheres draw two great circles perpendicular to the diameters PQ and AC, that pass through the points R and E; and let PpQ and AbC be two great circles, making equal indefinitely small angles NMP and BDd with the great circles PNQ and ABC. Let HK and FG, parallel to PQ and AC, be any two chords of the circles PpQ and AbC, that subtend similar arcs, or arcs contain-

ing the same number of degrees; and through HK and FG let planes perpendicular to the circles PpQ and AbC, be drawn to cut the portions of the spheres contained in the angles NMP and BDd; join RH, RK, MH, MK, DF, DG, EF, EG. Because the arcs subtended by HK and FG are like parts of their circumferences, it is plain that the angle RMH = EDF, and RMK = EDG. And because ED = MH = MK, and RM = DF = DG (hyp.), therefore RH = EF, and RK = EG.

Conceive the chords HK and FG, together with the planes passing through them, to change their place a little, so as to describe two slender prisms, or elements of the portions of the spheres contained in the angles NMP and BDd. It is plain that MX and DO, the distances of the chords HK and FG from the centres of their circles, are constantly proportional to MN and DB, the radii of the spheres; wherefore XT and OS, the perpendicular sections of the small prisms, are similar figures, and have to one another the same ratio that MX² has to DO², or MN² to DB². Now, the attraction of the prism HK urging a particle at R to the centre M, is

$$= XT \times \left(\frac{1}{RH} - \frac{1}{RK} \right), (10); \text{ and the attraction of the}$$

$$\text{prism FG urging a particle at E to the centre D, is}$$

$$= OS \times \left(\frac{1}{EF} - \frac{1}{EG} \right). \text{ But in consequence of what}$$

was proved, $\frac{1}{RH} - \frac{1}{RK} = \frac{1}{EF} - \frac{1}{EG}$; wherefore the attractions of the prisms are to one another as XT to OS, or as MN² to DB². The same thing may be proved of all the elements of the two portions of the spheres contained in the angles NMP and BDd; wherefore those portions attract particles at R and E with forces proportional to the squares of the radii of the spheres. But because the small angles NMP and BDd are equal, each of the spheres may be divided into an equal number of such portions; wherefore the attractions of the whole spheres upon particles placed at R and E are proportional to the squares of the radii of the spheres.

Cor. This proposition is true when the particles of matter attract one another with forces proportional to any proposed function of the distance.

Let RH = EF = f, and RK = EG = f'; then, adopting the same notation as before (10, Cor.), the attractions of the prisms urging particles placed at R and E to the centres M and D, are respectively XT × ± [Ψ(f) - Ψ(f')], and OS × ± [Ψ(f) - Ψ(f')]; consequently, those attractions have the same proportion that XT has to OS, or MN² to DB². Wherefore the attractions of the whole spheres are in the same proportion.

14. A particle placed anywhere without a sphere of homogeneous matter which attracts in the inverse proportion of the square of the distance, will be urged to the centre of the sphere with a force that is inversely proportional to the square of the particle's distance from the centre.

Let ABC (Plate CI. fig. 8) be the sphere, O its centre, and P a particle without the sphere: conceive a concentric sphere PMN, of the same homogeneous matter with the sphere ABC, to be described with the radius PO. Then, by the last proposition, the attraction of the sphere ABC upon the particle P is to the attraction of the sphere PMN, upon a particle placed at A, as AO² to PO². But the attraction of the sphere PMN upon a particle placed at A is equal to the attraction of the sphere ABC upon the same particle; for the attraction of the matter between the two spherical surfaces exerts no force upon a particle at A (9). Wherefore, in the proportion set down above, the two middle terms are con-

Attraction. stantly the same wherever the point P is placed without the sphere ABC; consequently the first term of the proportion must follow the inverse ratio of the last term; that is, the attraction of the sphere ABC upon the external particle at P is inversely proportional to PO^2 .

15. *The same law of attraction being supposed, a homogeneous sphere will attract a particle placed without it, with the same force as if all the matter of the sphere were collected in the centre.*

Let f denote the distance of the particle from the centre; then it follows, from the last proposition, that the attraction of the sphere upon the particle will have for its measure $\frac{A}{f^2}$; A denoting a constant quantity that will be determined by any particular case; that is, by the actual attractive force corresponding to any determinate distance from the centre. Let r denote the radius of the sphere, and M its mass; then no part of the matter of the sphere being nearer the attracted particle than $(f-r)$, and none of it more remote than $(f+r)$, the attraction of the sphere on the particle will be greater than $\frac{M}{(f+r)^2}$, and less than $\frac{M}{(f-r)^2}$. Therefore $\frac{A}{f^2}$ is always contained between those limits, which requires that $A = M$. For, if A were greater than M , such values of f might be found as would make $\frac{A}{f^2}$ equal to or greater than $\frac{M}{(f-r)^2}$; and if A were less than M , such values of f might be found as would make $\frac{A}{f^2}$ equal to or less than $\frac{M}{(f+r)^2}$. Therefore $A = M$; and the attraction of the sphere is equal to $\frac{M}{f^2}$, or the same as if all the matter were collected in the centre.

If the radius of the sphere $= r$, the density of the matter contained in it $= d$; then the mass, or M , $= \frac{4\pi r^3 d}{3}$ (π being the circumference of the circle whose diameter is unit), and the attraction of the sphere at the distance f from the centre $= \frac{4\pi r^3 d}{3f^2}$. This is still true at the surface of the sphere when $f = r$, so that the attraction at the surface $= \frac{4\pi r d}{3}$; which expression, with the help of what is proved in (12), enables us to compare the intensities of the attractions of homogeneous spheres, at all distances from the centre, without or within the surfaces.

Cor. 1. A shell of homogeneous matter contained between two concentric spherical surfaces, will attract a particle placed without it, with the same force as if all the matter of the shell were collected in its centre.

For the attractive force of such a shell is equal to the difference of the attractions of two concentric spheres of the same homogeneous matter with the shell.

Cor. 2. A sphere composed of concentric shells, that vary in their densities according to any law, will attract a particle placed without it, with the same force as if all the matter were collected in the centre.

For this having been proved of one shell (*Cor. 1*), it must be true of any number of shells.

If $\phi(r)$ denote the density at the distance r from the centre, the quantity of matter in the sphere will be $= 4\pi \cdot \int \phi(r) \cdot r^2 dr$; and the attraction on a particle

without the sphere at the distance f from the centre

$$= \frac{4\pi \cdot \int \phi(r) \cdot r^2 dr}{f^2}.$$

16. *Two spheres, each composed of concentric shells of variable density, attract one another with the same force as if all the matter of each were collected in its centre.*

For the attraction of a sphere A upon every particle of another sphere B will remain the same, if we suppose all the matter of A to be collected in its centre (15). But the attraction of any particles of matter placed in A's centre upon the sphere B is equal and opposite to the attraction of B, upon the same matter so placed; and again, the attraction of B upon all the particles placed in the centre of A, will remain unchanged, if we suppose the matter of B to be collected in its centre. Wherefore A attracts B with the same force as if the matter of each were collected in its centre.

17. *Supposing that the particles of matter attract with a force proportional to the distance, a body of any shape will attract a particle of matter placed anywhere with the same force, and in the same direction, as if all the matter of the body were collected in its centre of gravity.*

Suppose that the attracted particle is placed at P (fig. 9), and the centre of gravity of the attracting body at G; join PG, and let any plane pass through that line. Let L be a small part, or element of the body, and from L draw LK perpendicular to the plane passing through PG, and KF perpendicular to PG; join PL and PK. Put dm to denote the quantity of matter, or the mass of the element L; then its attractive force, urging the particle in the direction PL, is $= PL \times dm$, which, by the resolution of forces, is equivalent to the two forces $PK \times dm$ and $KL \times dm$; and again, the single force $PK \times dm$ is equivalent to the two forces $FK \times dm$, and $PF \times dm$ $= PG \times dm + GF \times dm$. Wherefore, the attraction of the element L upon the particle at P is equivalent to these four separate forces, viz. $PG \times dm$, $GF \times dm$, $FK \times dm$, $KL \times dm$, which urge the particle P respectively in the directions PG, GF, FK, KL. But, from the nature of the centre of gravity, the sum of all the forces, $KL \times dm$, that urge the particle P to one side of the plane passing through PG, is just equal to the sum of the forces that urge it to the other side of the same plane; and the sum of all the forces, $FK \times dm$, that urge P to one side of the line PG, is just equal to the sum of the forces that urge it to the other side of the same line; and the sum of all the forces, $GF \times dm$, that urge P towards the point G, is just equal to the sum of the forces that urge it from the same point. Wherefore all the preceding forces mutually destroy one another, excepting the forces $PG \times dm$, the sum of which, when extended to all the elements of the attracting body, is $= PG \times$ mass of the body. Wherefore the whole attraction upon P is the same as if all the matter of the body were collected in its centre of gravity.

Cor. Supposing that the particles of matter attract with a force proportional to the distance, a homogeneous sphere will attract a particle placed anywhere, in the same manner as if all the matter of the sphere were collected in the centre.

For the centre of gravity of a homogeneous sphere is the same as the centre of its figure. This corollary is likewise true of a sphere composed of concentric shells of variable density; and it is easy to apply the demonstration of (16) to prove that, in this law of attraction, two spheres, each composed of concentric shells of variable density, will attract one another with the same force as if the matter of each were collected in its centre.

18. *To investigate what are the laws of attraction in re-*

Attraction. *gard to the distance according to which a shell of homogeneous matter, contained between two concentric spherical surfaces, will attract a particle placed without it, in the same manner as if all the matter of the shell were collected in the centre.*

It has been proved that this property actually belongs to homogeneous shells in the law of attraction which obtains in nature, and likewise when the particles of matter attract with a force proportional to the distance; but it is interesting to know whether it is confined to these two cases alone, or extends to other laws of attraction. This can only be discovered by a direct analysis.

Let $r = PC$ (fig. 10), the distance of the attracted point from the centre of the shell; $u = CA$, the radius of the inner surface of the shell; $f = PM$, the distance of P from any point in the surface. Having drawn the diameter AD through P , let AMD and AND be two great circles, making with one another an indefinitely small angle $MAN = dq$; and let two small circles BMG , bmg , indefinitely near one another, of which A and D are the poles, meet the former circles in M , N , m , n ; and draw MS , NS to the centre of the circle BMG . Put θ for the measure of the arc AM ; then $MS = u \sin. \theta$; $MN = dq \cdot u \sin. \theta$; $Mm = u d\theta$; and the quadrilateral space $MNnm = u^2 \cdot dq \cdot d\theta \sin. \theta$. We may suppose the thickness of the shell indefinitely small, since, if the property belong to an elementary shell indefinitely thin, it will be true of one of a determinate thickness, which can be resolved into such elements. Suppose the thickness of the shell to be $= du$; then the quantity of matter in the part standing upon the quadrilateral space $MNnm = u^2 du \cdot dq \cdot d\theta \sin. \theta$. Let $\phi(f)$ represent the direct attraction of a particle at M in the direction PM ; then its attraction directed to the centre $C = \phi(f) \times \frac{PS}{PM} = \frac{r-u \cos. \theta}{f} \times \phi(f)$; and the attraction of the element of the shell in the same direction $= u^2 du \cdot dq \cdot d\theta \sin. \theta \times \frac{r-u \cos. \theta}{f} \cdot \phi(f)$. This expression is proportional to dq , when θ and f remain constant; and therefore (denoting by π the circumference of the circle whose diameter is unit) the attraction of the whole zone contained between the small circles BMG , bmg , will be $= 2\pi \cdot u^2 du \cdot d\theta \sin. \theta \cdot \frac{r-u \cos. \theta}{f} \cdot \phi(f)$; and the attractive force of the whole shell will be

$$2\pi \cdot u^2 du \int d\theta \sin. \theta \cdot \frac{r-u \cos. \theta}{f} \cdot \phi(f);$$

the fluent to be extended from $\theta = 0$ to $\theta = \pi$.

Again, the quantity of matter in the shell is $= 4\pi \cdot u^2 du$; and the attraction of this matter placed in the centre, at the distance r from P , is $= 4\pi \cdot u^2 du \cdot \phi(r)$.

If now we equate the attraction of the shell to the attraction of its matter placed in the centre, and leave out the factors common to both, we shall get

$$2\phi(r) = \int d\theta \sin. \theta \cdot \frac{r-u \cos. \theta}{f} \cdot \phi(f),$$

the limits of the integral being the same as before.

But $f^2 = r^2 - 2ru \cos. \theta + u^2$; then $d\theta \sin. \theta = \frac{fdf}{ru}$; also

$r-u \cos. \theta = \frac{f^2 + r^2 - u^2}{2r}$; wherefore, by substitution, we get

$$4 \cdot r^2 \phi(r) \cdot u = \int (f^2 + r^2 - u^2) \cdot df \cdot \phi(f);$$

or, which is equivalent, $4 \cdot r^2 \phi(r) \cdot u =$

$$(f^2 + r^2 - u^2) \cdot \int df \cdot \phi(f) - 2 \int f df \int df \cdot \phi(f),$$

the limits of this integral being from $f = r - u$ to $f = r + u$, which correspond to $\theta = 0$ and $\theta = \pi$.

Now let $\int df \cdot \phi(f) = \Psi(f)$; and $\int f df \int df \cdot \phi(f) = \text{Attraction}$. $\int f df \cdot \Psi(f) = \Psi'(f)$; then, by taking the fluents between the proper limits, we get

$$4 \cdot r^2 \phi(r) \cdot u = 2r \cdot [(r+u) \Psi(r+u) - (r-u) \Psi(r-u)] - 2 [\Psi'(r+u) - \Psi'(r-u)].$$

If we develop the binomial functions in the last expression, all the even powers of u will disappear, and the odd powers only will remain; these last terms being all contained in this general formula,

$$\text{viz. } \frac{4}{1.2.3 \dots 2n+1}.$$

$$\left\{ r \cdot \frac{d^{2n+1} r \Psi(r)}{dr^{2n+1}} - \frac{d^{2n+1} \Psi(r)}{dr^{2n+1}} \right\} \cdot u^{2n+1};$$

and, observing that $\frac{d \cdot \Psi(r)}{dr} = r \Psi(r)$, the same expression

will become $\frac{4}{1.2.3 \dots 2n+1}$.

$$\left\{ r \cdot \frac{d^{2n+1} r \Psi(r)}{dr^{2n+1}} - \frac{d^{2n} r \Psi(r)}{dr^{2n}} \right\} \cdot u^{2n+1};$$

which, again, is more simply expressed thus, viz.

$$\frac{4r^2}{1.2.3 \dots 2n+1} \cdot \frac{d \cdot \left\{ \frac{1}{r} \cdot \frac{d^{2n} r \Psi(r)}{dr^{2n}} \right\}}{dr} \cdot u^{2n+1}.$$

Wherefore, by substituting the development instead of the functions, and then dividing by $4r^2 u$, we get

$$\phi(r) = \frac{d \cdot \Psi(r)}{dr} + \frac{1}{1.2.3} \cdot \frac{d \cdot \left\{ \frac{1}{r} \cdot \frac{d^2 r \Psi(r)}{dr^2} \right\}}{dr} \cdot u^2 + \frac{1}{1.2.3.4.5} \cdot \frac{d \cdot \left\{ \frac{1}{r} \cdot \frac{d^4 r \Psi(r)}{dr^4} \right\}}{dr} \cdot u^4 + \&c.$$

From the nature of the function $\Psi(r)$, we get $\phi(r) = \frac{d \cdot \Psi(r)}{dr}$; wherefore each of the remaining terms must be separately equal to nothing; hence

$$d \cdot \left\{ \frac{1}{r} \cdot \frac{d^2 r \Psi(r)}{dr^2} \right\} = 0;$$

from which we find $r \Psi(r) = \frac{1}{2} Ar^3 + A'r - A''$, A , A' , A'' being arbitrary constant quantities; and this value of $r \Psi(r)$, it is plain, will likewise render all the succeeding terms of the development evanescent. Wherefore

$$\phi(r) = \frac{d \cdot \Psi(r)}{dr} = Ar + \frac{A''}{r^2}.$$

Thus the most general expression of the law of attraction, that possesses the property in question, is a combination of the two laws above mentioned, with each of which it coincides, according as we make the one or other of the constant quantities equal to nothing. We have, therefore, a direct proof that the law of nature is the only one which will make the attraction decrease as the distance increases, and in which a spherical shell, or a sphere, will attract in the same manner as if all the matter were collected in the centre.

Laplace has arrived at the same conclusion by a different process. (*Méc. Céleste*, livre ii. chap. 2, No. 12, Rem. part.)

ATTRACTION OF SPHEROIDS OF REVOLUTION.

19. Let $APBQ$ (Plate CII. fig. 11) and $CMDN$ be two concentric ellipses, similar to one another, and similarly situated, of which AB and CD are either the greater or less

Attraction of spheroids of revolution.

Attraction. axes; and let PCQ be perpendicular to AB . Conceive the ellipses to revolve about PQ , so as to describe an indefinitely small angle; then, supposing the law of attraction to be inversely proportional to the square of the distance, the thin solid of homogeneous matter described by the ellipse $APBQ$ will attract a particle placed at P , in a direction perpendicular to any plane passing through PQ , with the same force that the thin solid of the same matter described by the ellipse $CMDN$, will attract a particle placed at C perpendicularly to the same plane.

From C draw CM , CN , making equal angles with CD , and PR , PT respectively parallel to CM , CN ; and let Cm , Cn , Pr , Pt , be drawn in the same manner, and indefinitely near the former lines. While the ellipses revolve about PQ , the small sectors will describe pyramids that have their vertices at C and P . It is manifest that the pyramids so described are similar; for their angles at C and P in the planes of the ellipses are equal; and their other angles, described by revolving about PQ , are likewise equal, because the sectors are equally inclined to that axis. Wherefore the direct attractions of all the small pyramids upon the particles P and C are proportional to the lengths PR , PT , CM , CN (7); and consequently the forces that urge the particles P and C in a direction at right angles to any plane passing through PQ are proportional to the perpendiculars let fall upon that plane from R , T , M , N . But because PR , PT , CM , CN are equally inclined to PQ , they will make equal angles with any plane passing through PQ ; wherefore the perpendiculars drawn to the plane from R , T , M , N , will be respectively proportional to PR , PT , CM , CN . But $CM + CN = PR + PT$ (6); wherefore the sum of the perpendiculars drawn to the plane from M and N will be equal to the sum of the perpendiculars drawn to it from R and T . Consequently the force of the pyramids PR and PT , which urges the particle P at right angles to the plane, is equal to the force of the pyramids CM and CN , which urges the particle C in a parallel direction. The same thing is true of all the small pyramids that make up the thin solids described by the ellipses $APBQ$ and $CMDN$; and it is therefore true of the whole solids.

It is to be observed that when the pyramids PR and PT fall on opposite sides of PQ , it is the difference of their attractions which is equal to the sum of the attractions of CM and CN ; and it is the difference of the perpendiculars let fall from T and R on opposite sides of the plane, which is equal to the sum of the perpendiculars let fall from M and N .

20. Let $APBQ$ be a spheroid of revolution, PQ the axis of revolution, and ACB a plane through the centre perpendicular to PQ (Plate CII. fig. 12). If D be a particle in the surface of the spheroid, and DL perpendicular to the plane ACB ; then the attraction of a spheroid on a particle placed at the pole P , will be to the force with which a particle placed at D is attracted in the direction DL , as PC is to DL .

Through D draw a plane parallel to the plane ACB , and let the plane so drawn cut the axis PQ in F ; draw the straight line DFE to terminate in the spheroid, and describe another spheroid through F , having the same centre with the spheroid $APBQ$, and similar to it, and similarly situated. Conceive an indefinitely great number of planes, making indefinitely small angles with one another, to be drawn through DE , so as to divide the two spheroids into an indefinitely great number of thin solids or slices; then the sections which every one of the planes make with the spheroids will be similar ellipses, having the same centre (5); and it is manifest that a straight line drawn through F at right angles to DE , in any one of the planes, will pass through the centre of the two el-

lipses contained in it, and will coincide with an axis of Attraction. each. Wherefore the force with which every one of the slices or elements of the spheroid $APBQ$ attracts a particle placed at D in the direction DL , is equal to the force with which the corresponding slice or element of the spheroid $GFHK$ attracts a particle placed at F in the direction FC (19). Wherefore, the whole attraction of the spheroid $APBQ$ upon a particle at D , in the direction DL , is equal to the whole attraction of the spheroid $GFHK$ upon a particle at F . But the attractions of the spheroids $APBQ$ and $GFHK$ upon particles placed at P and F , are to one another as PC to FC (8). Wherefore, the attraction of the spheroid $APBQ$ upon a particle at P , is to the force with which the same spheroid attracts a particle at D , in the direction DL , as PC is to FC or DL .

21. Let $APBQ$ be a spheroid of revolution, and PQ the axis of revolution as before. If D be a particle in the surface, $ADPB$ (fig. 13) a section through D , and the axis PQ and DL perpendicular to PQ ; the attraction of the spheroid upon a particle at A will be to the force with which a particle at D is attracted, in the direction DL , as AC is to DL .

Through D draw a plane perpendicular to AB , which cuts the section ADB in the straight line DFE ; and let a spheroid $FGHK$ be described through F , having the same centre with the spheroid $APBQ$, and similar to it, and similarly situated. Then, conceiving the two spheroids to be divided into an indefinitely great number of thin slices by planes passing through DE , the force with which every slice or element of the spheroid $APBQ$ attracts a particle at D in the direction DL , will be equal to the force with which the corresponding slice or element of the spheroid $FGHK$ attracts a particle at F (19). But the attractions of the spheroids $APBQ$ and $FGHK$ upon particles placed at A and F are to one another as AC to CF (8). Wherefore, the attraction of the spheroid $APBQ$ upon a particle at A is to the force with which the same spheroid attracts a particle at D , in the direction DL , as AC to FC or DL .

The two last propositions will enable us to find both the direction and the intensity of the attraction of a homogeneous spheroid of revolution upon a particle placed anywhere on the surface, when we have ascertained the attractive forces at the poles and at the circumference of the circular section made by a plane through the centre perpendicular to the axis. For the whole attraction at any point is the compound force arising from the attractions perpendicular to the axis, and parallel to it. The next object of our research is, therefore, to determine the two forces above mentioned, viz. the attraction at the poles, and at the circular section equally distant from both poles.

22. Let ABD be an indefinitely slender pyramid, of which the base BD is perpendicular to the edge AD (fig. 14); let B = base BD , and f = length AD ; then $\frac{B}{f}$ = the attraction of the whole matter of the pyramid upon a particle placed at the vertex A .

Let $AM = x$, then the section MN parallel to the base $BD = \frac{B \cdot x^2}{f^2}$, and MP = element of the prism = $\frac{B \cdot x^2 dx}{f^2}$, and the attraction of the element upon a particle placed at $A = \frac{MP}{AM^2} = \frac{B \cdot dx}{f^2}$, the fluent of which is $\frac{Bx}{f^2}$ = attraction of the pyramid AM upon a particle at A . And, when $x = f$, this becomes $\frac{B}{f}$ = attraction of the pyramid AD upon a particle placed at A .

Attraction. 23. To investigate the attraction of a homogeneous spheroid of revolution upon a particle placed at the pole.

Let P (fig. 15) be the pole, PCQ the axis of revolution, and APBQ a section of the spheroid by a plane passing through PQ, and any point M, in the surface; draw PM, Pm indefinitely near PM, and Mm perpendicular to Pm. Conceive the plane PMQ to revolve about PQ, so as to describe the indefinitely small angle BCO; then the small triangle MPm will describe a slender pyramid, having its vertex at P, and of which the base is a rectangle, contained by Mm and RT; for the point M moving parallel to R, it will describe a line equal and parallel to that described by R, namely, to RT.

Let PM = f, and the angle KPM, which PM makes with a perpendicular to the axis, = θ , and the indefinitely small angle BCO = $d\phi$. Then Mm = $f d\theta$, RT = CR $\times d\phi$ = $f \cos. \theta \cdot d\phi$, and B, the base of the slender pyramid described by the triangle MPm, = $d\phi \cdot d\theta \cos. \theta \cdot f^2$; wherefore the direct attraction of the pyramid on a particle at P = $\frac{B}{f}$ (22) = $d\phi \cdot d\theta \cos. \theta \cdot f$, and the elementary attraction of the spheroid in the direction PC = direct attraction of the pyramid $\times \frac{PS}{PM}$ = $d\phi \cdot d\theta \cos. \theta \sin. \theta \cdot f$.

Again, let MR = x, CR = y, PC = k, AC = k'; then $y = f \cos. \theta$, $x = k - f \sin. \theta$; if we substitute these values in the equation of the solid (Def. 1) we get

$$\frac{(k - f \sin. \theta)^2}{k^2} + \frac{f^2 \cos.^2 \theta}{k'^2} = 1; \text{ whence}$$

$$f = \frac{2k^2k'}{k^2} \cdot \frac{\sin. \theta}{\cos.^2 \theta + \frac{k'^2}{k^2} \sin.^2 \theta}.$$

By substituting the value of f just found in the preceding expression of the elementary attraction of the spheroid, it will become

$$\frac{2k^2k'}{k^2} \cdot d\phi \cdot \frac{d\theta \cos. \theta \cdot \sin.^2 \theta}{\cos.^2 \theta + \frac{k'^2}{k^2} \sin.^2 \theta};$$

which must be integrated from $\phi = 0$ to $\phi = 2\pi$, and from $\theta = 0$ to $\theta = \frac{\pi}{2}$, π denoting always the half-circumference when radius is unit.

In an oblate spheroid, k is less than k': put $k^2 = k'^2 e^2$, and $z = \sin. \theta$; then the element of the attractive force will become, by substitution,

$$\frac{2k^2k'}{k^2} \cdot d\phi \cdot \frac{z^2 dz}{1 - e^2 z^2} = \frac{2k'^2k \cdot d\phi}{k^2 e^3} \cdot \left\{ \frac{edz}{1 - e^2 z^2} - edz \right\};$$

and by integrating from $z = 0$ to $z = 1$, we get

$$\frac{2k'^2k \cdot d\phi}{k^2 e^3} \cdot [e - \text{arc. tan. } e]$$

for the force with which the matter between the planes PBQ and POQ urges the particle P to the centre. Wherefore the whole attractive force of the spheroid upon a particle at P is =

$$\frac{4\pi \cdot k'^2k}{k^2 e^3} \cdot [e - \text{arc. tan. } e].$$

And because $\frac{4\pi \cdot k'^2k}{3} = \text{mass of the spheroid} = M$, we get the measure of the attraction of the oblate spheroid upon a particle placed at the pole equal to

$$k \cdot \frac{3M}{k^3 e^3} \cdot [e - \text{arc. tan. } e].$$

In an oblong spheroid, k is greater than k'; put $k^2 = k'^2$

= $k'^2 e^2$, then the element of the attractive force will be-Attraction. come, by substitution,

$$\frac{2k'^2k}{k^2} \cdot d\phi \cdot \frac{z^2 dz}{1 - e^2 z^2} = \frac{2k'^2k \cdot d\phi}{k^2 e^3} \cdot \left\{ \frac{edz}{1 - e^2 z^2} - edz \right\};$$

whence, by proceeding as before, we get the measure of the attractive force of the oblong spheroid on a particle placed at the pole equal to

$$k \cdot \frac{3M}{k^3 e^3} \cdot \left\{ \frac{1}{2} \text{hyp. log. } \frac{1+e}{1-e} - e \right\}.$$

Cor. In an oblate spheroid differing little from a sphere, e^2 will be a very small fraction, of which we may reject the higher powers. When this is done, the preceding expression of the polar attraction, viz.

$$\frac{4\pi \cdot k k'^2}{k^2 e^3} \cdot (e - \text{arc. tan. } e),$$

will be = $4\pi k \cdot (1 + e^2) \cdot \left(\frac{1}{3} - \frac{1}{5} e^2 \right) = \frac{4\pi k}{3} \cdot \left(1 + \frac{2}{5} e^2 \right)$.

And, if $k' = k + r = k\sqrt{1 + e^2}$ be the radius of the equator, then $2\frac{r}{k} = e^2$, so that the attraction at the pole will be

$$\frac{4\pi k}{3} \cdot \left(1 + \frac{4}{5} \cdot \frac{r}{k} \right).$$

24. To investigate the attraction of a homogeneous spheroid of revolution on a particle placed in the circumference of the circular section made by a plane through the centre, at right angles to the axis of revolution.

Let P (Plate CII. fig. 16) be the pole, PC the axis of revolution, A a point in the circular section AOB, made by a plane through the centre perpendicular to PC. Let M be any point in the surface of the spheroid, AMO a section through A and M by a plane perpendicular to to AOB, Am a line in that plane indefinitely near AM, and Mm perpendicular to Am, MR perpendicular to AO, and RS to AB. Conceive the plane AMO to revolve about A, so as to describe an indefinitely small angle OAQ; then the triangle AMm will describe a slender pyramid, having its vertex at A, and of which the base is equal to a rectangle contained by Mm and RT; for the point M moving parallel to the point R, it will describe a line equal to that described by R, namely, to RT.

Let AM = f, the angle MAR = θ , and the angle OAQ = $d\phi$; then Mm = $f d\theta$, and TR = AR $\times d\phi$ = $f \cos. \theta \cdot d\phi$. Wherefore B = base of the pyramid described by MAm = $d\phi \cdot d\theta \cos. \theta \cdot f^2$, and the direct attraction of the pyramid

in the direction AM = $\frac{B}{f}$ (22) = $d\phi \cdot d\theta \cos. \theta \cdot f$. Wherefore the elementary attraction of the spheroid in the direction AC = direct attraction of the pyramid $\times \frac{AR}{AM} \times \frac{AS}{AR}$

= $d\phi \cos. \phi \cdot d\theta \cos.^2 \theta \cdot f$. Again, let MR = x, RS = y, CS = z, CP = k, and AC = k'; then (Def. 1)

$$\frac{x^2}{k^2} + \frac{y^2 + z^2}{k'^2} = 1.$$

But $x = f \sin. \theta$, $y = AR \cdot \sin. \phi = f \cos. \theta \sin. \phi$, and $z = k' - f \cos. \theta \cos. \phi$; wherefore, by substitution, we get $\frac{f^2 \sin.^2 \theta}{k^2} + \frac{f^2 \cos.^2 \theta \sin.^2 \phi}{k'^2} + \frac{(k' - f \cos. \theta \cos. \phi)^2}{k'^2} = 1$.

From this equation we get

$$f = 2k' \cdot \frac{\cos. \theta \cos. \phi}{\cos.^2 \theta + \frac{k'^2}{k^2} \sin.^2 \theta}.$$

Let this value of f be substituted in the expression of the elementary attraction of the spheroid before found, and it will become

Attraction.

$$2k' \cdot d\phi \cos^2 \phi \cdot \frac{d\theta \cos^3 \theta}{\cos^2 \theta + \frac{k^2}{k'^2} \sin^2 \theta};$$

which expression, when integrated from $\phi = 0$ to $\phi = \pi$, and from $\theta = 0$ to $\theta = \frac{1}{2}\pi$, will give the attraction of half the spheroid: and the double of it, viz.

$$4k' \cdot d\phi \cos^2 \phi \cdot \frac{d\theta \cos^3 \theta}{\cos^2 \theta + \frac{k^2}{k'^2} \sin^2 \theta},$$

being integrated between the same limits, will give the whole attraction of the spheroid.

In the oblate spheroid, k is less than k' : Let $k^2 - k'^2 = k^2 e^2$, and $z = \sin. \theta$; and, by substitution, the element of the attractive force will become

$$4k' \cdot d\phi \cos^2 \phi \cdot \frac{dz(1 - z^2)}{1 + e^2 z^2} =$$

$$4k' \cdot d\phi \cos^2 \phi \cdot \frac{1 + e^2}{e^3} \cdot \left\{ \frac{edz}{1 + e^2 z^2} - \frac{edz}{1 + e^2} \right\}.$$

And by integrating from $z = 0$ to $z = 1$, we get

$$4k' \cdot d\phi \cos^2 \phi \cdot \frac{1 + e^2}{e^3} \cdot \left\{ \text{arc. tan. } e - \frac{e}{1 + e^2} \right\};$$

for the force with which the matter between the sections that contain the angle OAQ attracts the particle A to the centre. But $\int d\phi \cos^2 \phi = \int \frac{d\phi}{2} \cdot (1 + \cos. 2\phi)$

$= \frac{\phi}{2} + \frac{1}{4} \sin. 2\phi$; the value of which, between the limits

$\phi = 0$, and $\phi = \pi$, is $= \frac{\pi}{2}$: wherefore the attraction of the spheroid on a particle at A is equal to

$$2\pi \cdot k' \frac{1 + e^2}{e^3} \cdot \left\{ \text{arc. tan. } e - \frac{e}{1 + e^2} \right\}.$$

Because $\frac{4\pi \cdot k^2 k}{3} = \frac{4\pi \cdot k^3 \cdot (1 + e^2)}{3} = M$; we get

$2\pi \cdot (1 + e^2) = \frac{3M}{2k^3}$: wherefore the measure of the attractive force of the oblate spheroid on a particle placed anywhere in the circumference of the circular section made by a plane through the centre at right angles to the axis, is equal to

$$k \cdot \frac{3M}{2k^3 \cdot e^3} \cdot \left\{ \text{arc. tan. } e - \frac{e}{1 + e^2} \right\}.$$

In the oblong spheroid, k is greater than k' ; put $k^2 - k'^2 = k^2 e^2$, then the element of the attractive force will become, by substitution,

$$4k' \cdot d\phi \cos^2 \phi \cdot \frac{dz(1 - z^2)}{1 - e^2 z^2} = 4k' \cdot d\phi \cos^2 \phi \cdot \frac{1 - e^2}{e^3} \cdot \left\{ \frac{edz}{1 - e^2} - \frac{edz}{1 - e^2 z^2} \right\};$$

whence, by proceeding as before, we get the measure of the attractive force of the oblong spheroid upon a particle placed anywhere in the circumference of the circular section made by a plane through the centre at right angles to the axis, equal to

$$k' \cdot \frac{3M}{2k^3 \cdot e^3} \cdot \left\{ \frac{e}{1 - e^2} - \frac{1}{2} \text{hyp. log. } \frac{1 + e}{1 - e} \right\}.$$

Cor. In an oblate spheroid, differing little from a sphere, the higher powers of e^2 may be neglected. The expression of the attractive force at the equator, viz.

$$2\pi \cdot k' \cdot \frac{1 + e^2}{e^3} \cdot \left\{ \text{arc. tan. } e - \frac{e}{1 + e^2} \right\},$$

will then become

$$2\pi \cdot k' \cdot (1 + e^2) \left(\frac{2}{3} - \frac{4}{5} e^2 \right) = \frac{4\pi k'}{3} \cdot (1 - \frac{1}{5} e^2).$$

And if k' , the radius of the equator, $= k + \tau$; then $\frac{2\tau}{k} = e^2$ Attraction.

(23, Cor.); and the attraction at the equator will be equal to $\frac{4\pi k}{3} \cdot \left(1 + \frac{\tau}{k}\right) \cdot \left(1 - \frac{2}{5} \cdot \frac{\tau}{k}\right) = \frac{4\pi k}{3} \cdot \left(1 + \frac{3}{5} \cdot \frac{\tau}{k}\right)$.

25. An oblate spheroid of revolution being given, it is required to find the measures of the attractive forces that urge a particle placed anywhere in the surface, in a direction perpendicular to the axis, and in a direction parallel to it.

Let k and k' be the semiaxes of the ellipse, by the revolution of which the spheroid is described, k being the axis about which it revolves; and let b be the perpendicular distance of the particle from the axis, and a its distance from the plane, drawn through the centre at right angles to the axis: then, from what was proved in (20) and (21), the attractions sought will be found by multiplying the attractions at the pole, and at the circular section equally distant from both poles, by $\frac{a}{k}$ and $\frac{b}{k'}$.

Thus we get the attraction in the direction of a equal to

$$a \times \frac{3M}{k \cdot e^3} \cdot [e - \text{arc. tan. } e],$$

and the attraction in the direction of b equal to

$$b \times \frac{3M}{2k^3 \cdot e^3} \cdot \left\{ \text{arc. tan. } e - \frac{e}{1 + e^2} \right\}.$$

The same formulæ likewise serve for finding the attractions upon a particle placed anywhere within the spheroid. For the attraction upon a particle within the spheroid is equal to the attraction of a similar concentric spheroid, which contains the particle in its surface (9); and it is evident that the co-efficients which multiply a and b in the above expressions depend only upon the proportion of k and k' , and they are therefore the same for all similar spheroids.

If we denote by A and B the co-efficients of a and b in the expressions of the attractive force found above, the whole attraction of the spheroid, which is compounded of the forces $a \cdot A$ and $b \cdot B$, will be $= \sqrt{a^2 A^2 + b^2 B^2}$. And if Ψ denote the angle which the direction of this force makes with a , or with the axis of the spheroid; then

$$\tan. \Psi = \frac{b \cdot B}{a \cdot A}.$$

Cor. In the very same manner we may determine the attractions of an oblong spheroid of revolution, upon a point in the surface, or within the solid.

26. If k, k', k'' , the semiaxes of a homogeneous ellipsoid, be related to h, h', h'' , those of another ellipsoid of the same matter, so that $k^2 - k'^2 = h^2 - h'^2$ and $k'^2 - k''^2 = h'^2 - h''^2$, the attractions perpendicular to the planes of the principal sections, which the first ellipsoid (Plate CH. fig. 17) exerts upon a point determined by the co-ordinates $h \sin. m, h' \cos. m \sin. n, h'' \cos. m \cos. n$, respectively parallel to k, k', k'' , will be to the attractions which the second ellipsoid exerts upon a point determined by the co-ordinates $k \sin. m, k' \cos. m \sin. n, k'' \cos. m \cos. n$, respectively parallel to h, h', h'' , in the direct proportion of the areas of the principal sections to which the attractions are perpendicular.

This proposition is an extension to all elliptical spheroids of what was proved of the sphere in (13). It is here enunciated of the ellipsoid, because the demonstration is not more difficult for that solid than for spheroids of revolution.

Let ABDM be an ellipsoid, the semiaxes of which are $BC = k, EC = k'$, and $AC = k''$; and $abdm$ another ellipsoid, of which the semiaxes are $bc = h, ec = h'$, and $ac = h''$; those quantities being so related that $k^2 - k'^2 = h^2 - h'^2$, and $k'^2 - k''^2 = h'^2 - h''^2$. Also, let G be a point about the ellipsoid ABDM, so determined that GH, parallel to BC, $= h \sin. m$; HK, parallel to CE, $= h' \cos. m$

Attraction. $\sin. n$; and $CK = h'' \cos. m \cos. n$; and let g be a point about the ellipsoid $abdm$, so determined that gh , parallel to bc , $= k \sin. m$; hk , parallel to ce , $= k' \cos. m \sin. n$; and $ck = h'' \cos. m \cos. n$. Then the force with which the ellipsoid $ABDM$ attracts a particle placed at G in the direction GH , will be to the force with which the ellipsoid $abdm$ attracts a particle placed at g in the direction gh , as the area of the section $AEDM$ to the area of the section $aedm$, or as $k' k''$ to $h' h''$.

Let $RP = k \sin. \theta$; $PO = k' \cos. \theta \sin. \phi$; and $CO = k'' \cos. \theta \cos. \phi$; which suppositions are allowable, because they satisfy the equation of the ellipsoid (Def. 1), whatever be the angles θ and ϕ . Draw CPM through the centre, and CN indefinitely near it; then $CP = \cos. \theta \sqrt{k'^2 \sin.^2 \phi + k''^2 \cos.^2 \phi}$; and when $\cos. \theta = 1$, $CM = \sqrt{k'^2 \sin.^2 \phi + k''^2 \cos.^2 \phi}$; wherefore $\frac{CP}{CM} = \cos. \theta$.

Let the angle $DCM = \Psi$; then $\tan. \Psi = \frac{PO}{CO} = \frac{k'}{k''} \tan. \phi$;

and, by taking the fluxions, $\frac{d\Psi}{\cos.^2 \Psi} = \frac{k'}{k''} \cdot \frac{d\phi}{\cos.^2 \phi}$; but $\frac{1}{\cos.^2 \Psi} = 1 + \tan.^2 \Psi = \frac{k'^2 \sin.^2 \phi + k''^2 \cos.^2 \phi}{k''^2 \cos.^2 \phi} = \frac{CM^2}{k''^2 \cos.^2 \phi}$;

wherefore $d\Psi \cdot CM^2 =$ twice the sector $MCN = k' k'' \cdot d\phi$.

And, in like manner, in the other ellipsoid, if $rp = h \sin. \theta$; $po = h' \cos. \theta \sin. \phi$; and $co = h'' \cos. \theta \cos. \phi$: then $\frac{cp}{cm} = \cos. \theta$, and twice the sector $mcn = h' h'' d\phi$.

It is plain, from what has been shown, that, when θ varies and ϕ remains constant in the expressions of the co-ordinates, the points P and p will move along CM and cm , so that, in every position, $\frac{PC}{MC} = \frac{pc}{mc}$. Let Q and q be indefinitely near P and p ; and through P and Q draw lines parallel to MN , and through p and q draw lines parallel to mn . Let S denote the quadrilateral contained between the parallels drawn through P and Q , and S' that contained

between the lines drawn through p and q : Then $\frac{S}{MCN} = \frac{QC^2 - PC^2}{MC^2}$, and $\frac{S'}{mcn} = \frac{qc^2 - pc^2}{mc^2}$; wherefore, since $\frac{PC}{MC} = \frac{pc}{mc}$, and $\frac{QC}{MC} = \frac{qc}{mc}$, it is manifest that $\frac{S}{S'} = \frac{MCN}{mcn} = \frac{k' k''}{h' h''}$.

Upon the quadrilaterals S and S' let upright prisms RS and rs be erected, and be prolonged to meet the surfaces of the spheroids; join GR , GS , gr , gs . Then, $GR^2 = (h \sin. m - k \sin. \theta)^2 + (h' \cos. m \sin. n - k' \cos. \theta \sin. \phi)^2 + (h'' \cos. m \cos. n - k'' \cos. \theta \cos. \phi)^2$;

$gr^2 = (h \sin. m - h \sin. \theta)^2 + (h' \cos. m \sin. n - h' \cos. \theta \sin. \phi)^2 + (h'' \cos. m \cos. n - h'' \cos. \theta \cos. \phi)^2$;

And, by expanding these expressions, we get

$GR^2 = [(h^2 + (h'^2 - h^2) \cos.^2 m \sin.^2 n + (h''^2 - h^2) \cos.^2 m \cos.^2 n) - 2(hk \sin. m \sin. \theta + h' k' \cos. m \cos. \theta \sin. n \sin. \phi + h'' k'' \cos. m \cos. \theta \cos. n \cos. \phi)]$;

and $gr^2 = [(h^2 + (h'^2 - h^2) \cos.^2 m \sin.^2 n + (h''^2 - h^2) \cos.^2 m \cos.^2 n) - 2(hk \sin. m \sin. \theta + h' k' \cos. m \cos. \theta \sin. n \sin. \phi + h'' k'' \cos. m \cos. \theta \cos. n \cos. \phi)]$.

These expressions are equal, because $k'^2 - h'^2 = h'^2 - h^2$, and $k''^2 - h''^2 = h''^2 - h^2$; wherefore $RG = rg = f$. And, in like manner, it is shown, that $GS = gs = f'$.

Now, the attraction of the prism RS urging a particle at G in the direction GH , is equal to $S \times \left\{ \frac{1}{f} - \frac{1}{f'} \right\}$ (10);

and the attraction of the prism rs urging a particle at g in the direction gh , is $= S' \times \left\{ \frac{1}{f} - \frac{1}{f'} \right\}$: wherefore these

attractions are to one another as S to S' , or as $k' k''$ to $h' h''$. The same thing may be proved of all the elementary prisms that make up the two portions of the ellipsoids contained between the planes BCM , BCN , and bcm , bcn ; wherefore those portions attract particles placed at G and g , with forces proportional to $k' k''$ and $h' h''$. But the two ellipsoids may be divided into an equal number of such portions; wherefore the ellipsoids attract particles placed at G and g , in the directions GH and gh , with forces proportional to $k' k''$ and $h' h''$, or to the sections $AMDE$ and $amde$.

Cor. 1. This proposition is true when the law of attraction is expressed by any function of the distance. The demonstration is the same as in the corollary of (13).

Cor. 2. If the two ellipsoids be so placed that their centres, and the planes of their principal sections, shall coincide, the surface of the one will be entirely within the other. Also the point which one ellipsoid attracts will be in the surface of the other, as is plain from the expressions of the co-ordinates. And hence the attraction of one ellipsoid upon a point without the surface is made to depend upon the attraction of another ellipsoid upon a point within the surface.

Cor. 3. When the ellipsoids become spheroids of revolution, the two principal sections through the axis of revolution become equal, and will be represented by any two sections whatever passing through the axis at right angles to one another. But, in this case, the attractions of the spheroids on the points may be reduced to two, one acting perpendicular to the axis, and one parallel to it; and it is plain that these attractions will be to one another as the areas of the sections perpendicular to their directions.

27. To find the attraction of an oblate spheroid upon a particle placed without the surface.

Let k' be the radius of the equator, and k the axis of revolution; and let a be the perpendicular distance of the point without the spheroid from the plane of the equator, and b its distance from the axis. In the first place, it is necessary to determine the semiaxis of another oblate spheroid that shall contain the given point in its surface, and such, that it shall have the same centre, and its equator in the same plane, as the given spheroid; and likewise the difference of the squares of its semiaxes equal to the difference of the squares of the semiaxes of the given spheroid. Let h' denote the radius of the equator, and h the semiaxis of the required spheroid; then, because the attracted point is to be in the surface of the solid, we have $\frac{a^2}{h^2} + \frac{b^2}{h'^2} = 1$; and, because

$h'^2 - h^2 = k'^2 - k^2 = \epsilon^2$, we get $\frac{a^2}{h^2} + \frac{b^2}{h'^2 - \epsilon^2} = 1$:

Whence,

$2 h^2 = a^2 + b^2 - \epsilon^2 + \sqrt{(a^2 + b^2 - \epsilon^2)^2 + 4 a^2 \epsilon^2}$; and when h is determined, then $h' = \sqrt{h^2 + \epsilon^2}$.

In consequence of the equation $\frac{a^2}{h^2} + \frac{b^2}{h'^2} = 1$, we may suppose $a = h \sin. m$, and $b = h' \cos. m$; let $a' = k \sin. m$, and $b' = k' \cos. m$; or $a' = \frac{k}{h} a$, and $b' = \frac{k'}{h'} b$: then the point determined by the co-ordinates a' and b' will be in the surface of the given spheroid, and consequently

Attraction. it will be within the surface of the other spheroid. Let M' denote the mass of the spheroid of which the axis is h ; and let $e^2 = \frac{h^2 - k^2}{h^2} = \frac{k'^2 - k^2}{h^2}$: then (25) the attractions of this spheroid upon the point within its surface, determined by the co-ordinates a and b , are these, viz.

That perpendicular to the equator, equal to

$$a \times \frac{3M'}{h^3 e^3} \cdot [e' - \text{arc. tan. } e'];$$

and that perpendicular to the axis, equal to

$$b \times \frac{3M'}{2h^3 e^3} \cdot \left\{ \text{arc. tan. } e' - \frac{e'}{1 + e^2} \right\}.$$

But (26, Cor. 3) the attractions of the given spheroid, whose semiaxes are h and k , upon the point without its surface determined by the co-ordinates a and b , will be found by multiplying the preceding expressions respectively by $\frac{k^2}{h^2}$ and $\frac{kk'}{hh'}$. Let M be the mass of the given

spheroid; then $\frac{M}{M'} = \frac{k^2 k}{h^2 h}$; consequently $\frac{k^2}{h^2} = \frac{M}{M'} \cdot \frac{h}{k} = \frac{M}{M'} \cdot \frac{a}{a'}$; and $\frac{kk'}{hh'} = \frac{M}{M'} \cdot \frac{h'}{h} = \frac{M}{M'} \cdot \frac{b}{b'}$: wherefore the attractions of the given oblate spheroid upon a point without the surface determined by the co-ordinates a and b , are as follows, viz.

The attraction perpendicular to the equator, equal to

$$a \times \frac{3M}{h^3 e^3} [e' - \text{arc. tan. } e'];$$

and that perpendicular to the axis, equal to

$$b \times \frac{3M}{2h^3 e^3} \left\{ \text{arc. tan. } e' - \frac{e'}{1 + e^2} \right\}.$$

Cor. In the very same manner we may determine the attractions of an oblong spheroid of revolution upon a point without the surface.

ATTRactions OF ELLIPSOIDS.

Attractions of ellipsoids.

28. Let $AMBN$ be one of the principal sections of an ellipsoid, C the centre, AB and MN the axes, D a point in the periphery of the section, and DO perpendicular to MN (Plate CII. fig. 18); the attraction of the ellipsoid upon a particle placed at the pole A is to the force with which a particle placed at D is attracted in the direction DO , as AC to DO .

Draw DFG perpendicular to AB , and through F describe an ellipsoid similar to the given ellipsoid, and similarly situated, and having the same centre. Conceive an indefinitely great number of planes, making indefinitely small angles with one another, to be drawn through DG , so as to divide the two ellipsoids into an indefinitely great number of thin solids or slices; then the sections of the ellipsoids made by every one of the planes will be similar and concentric ellipses, each of them having an axis perpendicular to DG (5). Wherefore the attractions of the elements of the ellipsoid $FHKL$, upon a particle at F , are respectively equal to the attractions of the elements of the ellipsoid $AMBN$, upon a particle at D in the direction DO (19). Wherefore the whole attraction of the ellipsoid $FHKL$, upon a particle at F , is equal to the attraction of the ellipsoid $AMBN$, upon a particle at D , in the direction DO . But the attractions of the ellipsoids $AMBN$ and $FHKL$, upon particles at A and F , are to one another as AC to CF (8). Wherefore the attraction of the ellipsoid $AMBN$, upon a particle at the pole A , is to the force with which it attracts a particle at D in the direction DO , as AC to DO .

29. The attractions of ellipsoids upon particles placed in

the surface, urging them in directions perpendicular to any Attraction. of the principal sections, are proportional to the distances of the particles from that section.

Let $AMBN$ be one of the principal sections of an ellipsoid, C the centre, AB and MN the axes of the section, and P a point in the surface of the solid: the attraction of the ellipsoid upon a particle at the pole A (Plate CII. fig. 19) is to the force with which a particle at P is attracted in a direction parallel to AB , as the semiaxis AC is to the distance of P from the principal section perpendicular to AC .

Draw PDQ perpendicular to the section $AMBN$, and let it meet the surface again in Q ; through D describe an ellipsoid similar to $AMBN$, similarly situated, and having the same centre; and through P draw a section $SPRQ$ perpendicular to AB . As before, divide the solids into an indefinitely great number of thin slices, by planes drawn through PQ : the sections made by every one of those planes will be similar, and concentric ellipses having an axis of each perpendicular to PQ (5). Wherefore the attractions of the elements of the ellipsoid $AMBN$, upon a particle at P , in a direction perpendicular to the plane $PRQS$, are respectively equal to the attractions of the elements of the ellipsoid $FHKL$ upon a particle at D , in a direction perpendicular to the same plane (19). Wherefore the attraction of the ellipsoid $AMBN$, upon a particle at P , in a direction parallel to the axis AB , is equal to the attraction of the ellipsoid $FHKL$ upon a particle at D in the same direction. But the ellipsoids $AMBN$ and $FHKL$ being similar, their attractions upon particles at A and F are to one another as AC to CF (8); and the attraction of the ellipsoid $FHKL$, upon a particle at the pole F , is to its attraction upon a particle at D , in a direction parallel to AC , as FC to CN (28). Wherefore (*ex æquali*) the attraction of the ellipsoid $AMBN$, upon a particle at the pole A , is to the force with which it attracts a particle at P , in the direction AC , as AC to CN .

This proposition will enable us to find the attractions of an ellipsoid on all points on the surface, or within the solid, when the attractions at the poles are determined.

30. To investigate the differential expressions of the attractions at the poles of an ellipsoid.

Let APD be an ellipsoid; C the centre; AC , CE , and PC , the semiaxes; and PMB a section made by a plane through PC and any point M in the surface: draw PM (fig. 20) indefinitely near PM , and Mm perpendicular to Pm ; also MR perpendicular to the plane ADB , MS perpendicular to PC , and RH perpendicular to AD . Conceive the plane PCB to revolve about PC , so as to describe an indefinitely small angle BCO ; and let $PM = f$; the angle KPM which PM makes with a perpendicular to the axis $= \theta$; and the angle $DCB = \phi$: then, by proceeding as in (23), it will be found that the attraction of the small pyramid described by the triangle MPm , urging a particle at P to the centre of the ellipsoid, is $= d\phi \cdot d\theta \cos. \theta \sin. \theta \cdot f$.

Again, let $MR = x$, $HR = y$, $CH = z$; also let $PC = k$, $AC = k'$, $CE = k''$; then $x = k - f \sin. \theta$; $y = f \cos. \theta \sin. \phi$; $z = f \cos. \theta \cos. \phi$; and if we substitute these values in the equation of the ellipsoid (Def. 2), we shall get

$$\frac{(k - f \sin. \theta)^2}{k^2} + \frac{f^2 \cos.^2 \theta \sin.^2 \phi}{k'^2} + \frac{f^2 \cos.^2 \theta \cos.^2 \phi}{k''^2} = 1:$$

whence

$$f = \frac{k}{\frac{\sin.^2 \theta}{k^2} + \frac{\cos.^2 \theta \sin.^2 \phi}{k'^2} + \frac{\cos.^2 \theta \cos.^2 \phi}{k''^2}} \cdot \frac{2 \sin. \theta}{\sin.^2 \theta + \cos.^2 \theta \sin.^2 \phi + \cos.^2 \theta \cos.^2 \phi}$$

This is the value of f at the pole of k ; and, by a like procedure, its values at the poles of k' and k'' may be found, viz.

Attraction.

$$f = \frac{k'}{k'^2} \cdot \frac{2 \sin. \theta}{\frac{\sin.^2 \theta}{k'^2} + \frac{\cos.^2 \theta \sin.^2 \varphi}{k^2} + \frac{\cos.^2 \theta \cos.^2 \varphi}{k'^2}}$$

$$f = \frac{k''}{k''^2} \cdot \frac{2 \sin. \theta}{\frac{\sin.^2 \theta}{k''^2} + \frac{\cos.^2 \theta \sin.^2 \varphi}{k^2} + \frac{\cos.^2 \theta \cos.^2 \varphi}{k'^2}}$$

Suppose that k is the least of the semiaxes; and let $k^2 = \frac{k^2}{m}$, and $k'^2 = \frac{k^2}{n}$; then the values of f at the poles of k, k', k'' , will be respectively

$$f = \frac{2 k \sin. \theta}{\sin.^2 \theta + m \cos.^2 \theta \sin.^2 \varphi + n \cos.^2 \theta \cos.^2 \varphi}$$

$$f = \frac{2 k' \sin. \theta \times m}{m \sin.^2 \theta + \cos.^2 \theta \sin.^2 \varphi + n \cos.^2 \theta \cos.^2 \varphi}$$

$$f = \frac{2 k'' \sin. \theta \times n}{n \sin.^2 \theta + \cos.^2 \theta \sin.^2 \varphi + m \cos.^2 \theta \cos.^2 \varphi}$$

Now let A, A', A'' , denote the attractions of the spheroid upon particles placed at the poles of k, k', k'' ; then, by substituting the values of f just found in the foregoing differential expression, we get

$$A = k \times \iint \frac{2 d \varphi . d \theta \cos. \theta \sin.^2 \theta}{\sin.^2 \theta + m \cos.^2 \theta \sin.^2 \varphi + n \cos.^2 \theta \cos.^2 \varphi}$$

$$A' = k' \times \iint \frac{m \times 2 d \varphi . d \theta \cos. \theta \sin.^2 \theta}{m \sin.^2 \theta + \cos.^2 \theta \sin.^2 \varphi + n \cos.^2 \theta \cos.^2 \varphi}$$

$$A'' = k'' \times \iint \frac{n \times 2 d \varphi . d \theta \cos. \theta \sin.^2 \theta}{n \sin.^2 \theta + \cos.^2 \theta \sin.^2 \varphi + m \cos.^2 \theta \cos.^2 \varphi}$$

the limits of the integrals being from $\theta = 0$ and $\varphi = 0$ to $\theta = \frac{\pi}{2}$ and $\varphi = 2\pi$.

31. To reduce the expressions of the polar attractions to the most simple integrals.

Let us consider the general expression

$$\iint \frac{d \varphi . d \theta \cos. \theta \sin.^2 \theta}{\alpha \sin.^2 \theta + \beta \cos.^2 \theta \sin.^2 \varphi + \gamma \cos.^2 \theta \cos.^2 \varphi}$$

which includes all the formulas found in (30). Let $p = \alpha \sin.^2 \theta + \beta \cos.^2 \theta$, and $q = \alpha \sin.^2 \theta + \gamma \cos.^2 \theta$; then the above expression will become

$$\iint \frac{d \varphi . d \theta \cos. \theta \sin.^2 \theta}{p \sin.^2 \varphi + q \cos.^2 \varphi}$$

Suppose $\sqrt{\left(\frac{q}{p}\right)} \cdot \frac{\sin. \varphi}{\cos. \varphi} = \frac{\sin. u}{\cos. u}$; then the preceding expression will become, by substitution,

$$\iint \frac{du . d \theta \cos. \theta \sin.^2 \theta}{\sqrt{p \cdot q}};$$

the limits of u being from 0 to 2π ; wherefore, by integrating with regard to u , and restoring the values of p and q , the integral becomes

$$2 \pi \cdot \int \frac{d \theta \cdot \cos. \theta \sin.^2 \theta}{\sqrt{(\alpha \sin.^2 \theta + \beta \cos.^2 \theta) \cdot (\alpha \sin.^2 \theta + \gamma \cos.^2 \theta)}}$$

and, by putting $x = \sin. \theta$, the integral, which is to be taken from $\theta = 0$ to $\theta = \frac{\pi}{2}$, or from $x = 0$ to $x = 1$, will become

$$2 \pi \cdot \int \frac{x^2 dx}{\sqrt{[\beta + (\alpha - \beta) x^2] \cdot [\gamma + (\alpha - \gamma) x^2]}}$$

If now we take α, β, γ , so as to make the assumed expression coincide with the quantities A, A', A'' , respectively, we shall get

$$A = 4 \pi k \cdot \int \frac{x^2 dx}{\sqrt{[m + (1 - m) x^2] \cdot [n + (1 - n) x^2]}}$$

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$$A' = 4 \pi k' \cdot \int \frac{m \cdot x^2 dx}{\sqrt{[1 + (m - 1) x^2] \cdot [n + (m - n) x^2]}}$$

$$A'' = 4 \pi k'' \cdot \int \frac{n \cdot x^2 dx}{\sqrt{[1 + (n - 1) x^2] \cdot [m + (n - m) x^2]}}$$

These expressions have the inconvenience of containing different factors in the denominators; but they may be reduced to others having the same factors, by putting

$$x = \frac{\tau}{\sqrt{m + (1 - m) \tau^2}} \text{ in the second, and } x =$$

$$\frac{\tau}{\sqrt{n + (1 - n) \tau^2}} \text{ in the third; we thus get}$$

$$A = 4 \pi k \cdot \int \frac{x^2 dx}{\sqrt{[m + (1 - m) x^2] \cdot [n + (1 - n) x^2]}}$$

$$A' = 4 \pi k' \cdot \int \frac{m \cdot \tau^2 d\tau}{[m + (1 - m) \tau^2]^{\frac{3}{2}} \cdot [n + (1 - n) \tau^2]^{\frac{1}{2}}}$$

$$A'' = 4 \pi k'' \cdot \int \frac{n \cdot \tau^2 d\tau}{[n + (1 - n) \tau^2]^{\frac{3}{2}} \cdot [m + (1 - m) \tau^2]^{\frac{1}{2}}}$$

Now let

$$\frac{1 - m}{m} = \frac{k'^2 - k^2}{k^2} = \lambda^2, \text{ and } \frac{1 - n}{n} = \frac{k''^2 - k^2}{k^2} = \lambda'^2;$$

$$\text{Also let the mass of the ellipsoid} = M = \frac{4 \pi k k' k''}{3}$$

$$= \frac{4 \pi k^3}{3 \sqrt{mn}}; \text{ then } \frac{3 M}{k^3} = \frac{4 \pi}{\sqrt{mn}}; \text{ wherefore, by substitution, we get}$$

$$A = k \cdot \frac{3 M}{k^3} \cdot \int \frac{x^2 dx}{\sqrt{(1 + \lambda^2 x^2) \cdot (1 + \lambda'^2 x^2)}}$$

$$A' = k' \cdot \frac{3 M}{k^3} \cdot \int \frac{x^2 dx}{[1 + \lambda^2 x^2]^{\frac{3}{2}} \cdot [1 + \lambda'^2 x^2]^{\frac{1}{2}}}$$

$$A'' = k'' \cdot \frac{3 M}{k^3} \cdot \int \frac{x^2 dx}{[1 + \lambda^2 x^2]^{\frac{1}{2}} \cdot [1 + \lambda'^2 x^2]^{\frac{3}{2}}}$$

the integrations extending from $x = 0$ to $x = 1$.

These integrals cannot be expressed in finite terms. When λ and λ' , or the eccentricities of the ellipsoid, are small, the values of the integrals may easily be found to a sufficient degree of exactness by series. They may likewise be all expressed by means of this fluent, viz.

$$F = \int \frac{dx}{\sqrt{(1 + \lambda^2 x^2) \cdot (1 + \lambda'^2 x^2)}} \text{ (from } x = 0 \text{ to } x = 1) \text{ and its partial fluxions. Thus we have, in general,}$$

$$\frac{x^2 dx}{\sqrt{(1 + \lambda^2 x^2) \cdot (1 + \lambda'^2 x^2)}} =$$

$$\frac{x^3}{\sqrt{(1 + \lambda^2 x^2) \cdot (1 + \lambda'^2 x^2)}} + \frac{1}{\lambda} \cdot \left(\frac{dF}{d\lambda}\right) + \frac{1}{\lambda'} \cdot \left(\frac{dF}{d\lambda'}\right).$$

Wherefore, making $x = 1$, we get

$$A = k \cdot \frac{3 M}{k^3} \cdot \left\{ \frac{1}{\sqrt{(1 + \lambda^2) \cdot (1 + \lambda'^2)}} + \frac{1}{\lambda} \cdot \left(\frac{dF}{d\lambda}\right) + \frac{1}{\lambda'} \cdot \left(\frac{dF}{d\lambda'}\right) \right\}$$

$$A' = k' \cdot \frac{3 M}{k^3} \cdot \frac{1}{\lambda} \cdot \left(\frac{dF}{d\lambda}\right).$$

$$A'' = k'' \cdot \frac{3 M}{k^3} \cdot \frac{1}{\lambda'} \cdot \left(\frac{dF}{d\lambda'}\right).$$

32. To find the forces with which a homogeneous ellipsoid attracts a particle placed in the surface, or within the solid, in directions perpendicular to the principal sections.

Let k, k', k'' , denote the semiaxes of an ellipsoid, and a, b, c (respectively parallel to k, k', k'') the perpendicular distances of a particle placed in the surface, or within

Attraction. the solid, from the principal sections: then, from what is proved in (29), the attractions we are seeking will be found by multiplying the polar attractions by $\frac{a}{h}, \frac{b}{h'}, \frac{c}{h''}$.

Wherefore the forces that urge the particle in the directions of a, b , and c , are respectively $a \times \frac{3M}{h^3}$.

$$\left\{ \frac{1}{\sqrt{(1+\lambda^2)(1+\lambda'^2)}} + \frac{1}{\lambda} \cdot \left(\frac{dF}{d\lambda} \right) + \left(\frac{dF}{d\lambda'} \right) \right\};$$

$$b \times \frac{3M}{h^3} \cdot \frac{1}{\lambda'} \cdot \left(\frac{dF}{d\lambda'} \right);$$

$$\text{and } c \times \frac{3M}{h^3} \cdot \frac{1}{\lambda''} \cdot \left(\frac{dF}{d\lambda''} \right);$$

Which formulas serve both for points in the surface and within the solid, for the reason already explained in (25).

33. To find the attractions of an ellipsoid upon a particle placed without the surface.

Let h, h', h'' , be the semiaxes of the ellipsoid, and a, b, c (respectively parallel to h, h', h'') the co-ordinates of a particle without the surface. Let h, h', h'' , so related to h, h', h'' , that $h'^2 - h^2 = k'^2 - k^2$ and $h''^2 - h^2 = k''^2 - k^2$, denote the semiaxes of another ellipsoid, which contains the attracted point in its surface, and has its principal sections in the same planes as the given ellipsoid: then, because the attracted point is in the surface, we have (Def. 2)

$$\frac{a^2}{h^2} + \frac{b^2}{h'^2} + \frac{c^2}{h''^2} = 1;$$

and, because $h'^2 - h^2 = k'^2 - k^2 = \epsilon^2$, and $h''^2 - h^2 = k''^2 - k^2 = \epsilon'^2$, we get

$$\frac{a^2}{h^2} + \frac{b^2}{h^2 + \epsilon^2} + \frac{c^2}{h^2 + \epsilon'^2} = 1.$$

This equation now contains only one unknown quantity; and it is plain that one value of h , and only one, can be found from it. For, when $h = 0$, the function on the left hand side is infinitely great; and while h increases from 0 *ad infinitum*, the same function decreases continually from being infinitely great to be infinitely little. When h is found, then $h' = \sqrt{h^2 + \epsilon^2}$, and $h'' = \sqrt{h^2 + \epsilon'^2}$. Because a, b, c , are the co-ordinates of a point in the surface of the ellipsoid, we may suppose $a = h \sin. m$, $b = h' \cos. m \sin. n$, $c = h'' \cos. m \cos. n$; let $a' = h \sin. m$, $b' = h' \cos. m \sin. n$, $c' = h'' \cos. m \cos. n$; or $a' = \frac{h}{h} \times a$, $b' = \frac{h'}{h} \times b$, $c' = \frac{h''}{h} \times c$; then a', b', c' , will be the co-ordinates of a point in the surface of the given ellipsoid, and consequently it will be within the other solid. Let M' denote the mass of the ellipsoid of which h, h', h'' , are the semiaxes; also let $\lambda^2 = \frac{h'^2 - h^2}{h^2} = \frac{k'^2 - k^2}{k^2}$; and $\lambda'^2 = \frac{h''^2 - h^2}{h^2} = \frac{k''^2 - k^2}{k^2}$; then, F denoting the same fluent as before, the attractions of this ellipsoid upon the point within it, determined by the co-ordinates a', b', c' , in the directions of those co-ordinates, are (32) respectively equal to

$$a' \times \frac{3M'}{h^3} \left\{ \frac{1}{\sqrt{(1+\lambda^2)(1+\lambda'^2)}} + \frac{1}{\lambda} \cdot \left(\frac{dF}{d\lambda} \right) + \left(\frac{dF}{d\lambda'} \right) \right\},$$

$$b' \times \frac{3M'}{h^3} \times \frac{1}{\lambda'} \cdot \left(\frac{dF}{d\lambda'} \right), \text{ and}$$

$$c' \times \frac{3M'}{h^3} \times \frac{1}{\lambda''} \cdot \left(\frac{dF}{d\lambda''} \right).$$

Now, the attractions of the given ellipsoid upon the point without the surface, determined by the co-ordinates a, b, c , will be found (26) by multiplying the preceding

expressions respectively by $\frac{h' h''}{h h' h''}, \frac{h h''}{h h' h''}, \frac{h h'}{h h' h''}$. Let M be

the mass of the given ellipsoid; then $\frac{M}{M'} = \frac{h h' h''}{h h' h''}$; conse-

quently $\frac{h' h''}{h h' h''} = \frac{M}{M'} \cdot \frac{h}{h} = \frac{M}{M'} \cdot \frac{a}{a'}$; $\frac{h h''}{h h' h''} = \frac{M}{M'} \times \frac{b}{b'}$; and

$\frac{h h'}{h h' h''} = \frac{M}{M'} \times \frac{c}{c'}$; wherefore the attractions of the given

ellipsoid upon the point without the surface, determined by a, b, c , in the directions of those co-ordinates, are re-

spectively equal to $a \times \frac{3M}{h^3} \times$

$$\left\{ \frac{1}{\sqrt{(1+\lambda^2)(1+\lambda'^2)}} + \frac{1}{\lambda} \left(\frac{dF}{d\lambda} \right) + \frac{1}{\lambda'} \cdot \left(\frac{dF}{d\lambda'} \right) \right\},$$

$$b \times \frac{3M}{h^3} \times \frac{1}{\lambda'} \cdot \left(\frac{dF}{d\lambda'} \right), \text{ and}$$

$$c \times \frac{3M}{h^3} \times \frac{1}{\lambda''} \cdot \left(\frac{dF}{d\lambda''} \right).$$

The preceding propositions contain a complete theory of homogeneous elliptical spheroids. They enable us to compute the attractive force with which a solid of this kind urges a particle placed anywhere in the surface, within the solid, or without it. It remains, indeed, to find the exact value of the function F in its general form, to which we can do no more than approximate by series; but this is an analytical difficulty which it is impossible to overcome, because the nature of this function is such that it cannot be expressed in finite terms by the received notation of analysis.

In the preceding investigations we have followed the method of Maclaurin for points situated in the surface of a spheroid or within the solid. This method has always been justly admired; but neither its inventor, nor, as far as we know, any other geometer, has applied it, excepting to spheroids of revolution; and it is here, for the first time, extended to ellipsoids. In regard to points without the surface, we have employed the method first given by Mr Ivory, in the *Philosophical Transactions* for 1809. The combination of these two methods has enabled us to derive the attractions of an ellipsoid on a point placed anywhere from the attractions at the poles. Thus, this extremely complicated problem has, by geometrical reasoning of no great difficulty, been reduced to the investigation of the polar attractions, which are the only cases that require a direct computation.

34. Of the attractions of spheroids composed of elliptical shells that vary in their densities and figures according to any law.

When a spheroid is composed of concentric elliptical shells of variable density and figure, we may consider every shell as the difference of two homogeneous spheroids of the same density with the shells, and having their surfaces coinciding with the surfaces of the shell. The attractions of the spheroids being computed by the preceding methods, their difference will be equal to the attractions of the shell, and the integral obtained by summing the attractions of all the shells will give the attractions of the heterogeneous spheroid. This case, therefore, gives rise to no new difficulties, except such as are purely mathematical, and depend upon the law according to which the densities and figures of the shells are supposed to vary. (K. K.)

Attribute
||
Atwood.

ATTRACTION OF MOUNTAINS. See MOUNTAINS.

ATTRIBUTE, in a general sense, is that which may be predicated of a person or thing as a determining characteristic, inherent quality or accident, the negation of which involves either a falsehood, a contradiction, or an absurdity. Thus understanding is an attribute of mind, and extension an attribute of matter. That attribute which the mind conceives as the foundation of all the rest is called its *essential attribute*; thus extension is by some, and solidity by others, considered the essential attribute of matter.

ATTRIBUTES, in *Theology*, the several qualities or perfections of the divine nature.

ATTRIBUTES, in *Logic*, are the predicates of any subject, or what may be affirmed or denied of any thing.

ATTRIBUTIVES, in *Grammar*, are words which are significative of attributes; and thus include adjectives, verbs, and particles, which are attributes of substances, together with adverbs, which denote the attributes only of attributes. Mr Harris, who introduced this distribution of words, denominates the former *attributives of the first order*, and the latter *attributives of the second order*.

ATTRUCK, a river of Persia, which has its rise in a branch of the Elburz Mountains that borders on the northern deserts of Khorassan. It collects the streams of an extensive valley, and of several subordinate glens, and conveys in a westerly direction to the desert a large body of water, which being joined by several other streams, falls into the Caspian Sea at Kooroo-Soofee, 40 or 50 miles to the north of Asterabad.

ATTU, or ATTOO, one of the Aleutian Islands, about 60 miles in length, mountainous, and covered with snow, but inhabited. It is 215 miles east of Behring's Island. Long. 172. E. Lat. 54. N.

ATWOOD, GEORGE, an author celebrated for the accuracy of his mathematical and mechanical investigations, and considered particularly happy in the clearness of his explanations, and the elegance of his experimental illustrations, was born in the early part of the year 1746. He was educated at Westminster school, where he was admitted in 1759. Six years afterwards he was elected *off* to Trinity College, Cambridge. He took his degree of bachelor of arts in 1769, with the rank of third *wrangler*; Dr Parkinson of Christ's College being senior of the year. This distinction was amply sufficient to give him a claim to further advancement in his own college, on the list of which he stood the foremost of his contemporaries; and in due time he obtained a fellowship, and was afterwards one of the tutors of the college. He became master of arts in 1772, and in 1776 was elected a fellow of the Royal Society of London.

The higher branches of the mathematics had, at this period, been making some important advances at Cambridge, under the auspices of Dr Waring, and many of the younger members of the university became diligent labourers in this extensive field. Mr Atwood chose for his peculiar department the illustration of mechanical and experimental philosophy, by elementary investigations and ocular demonstrations of their fundamental truths. He delivered, for several successive years, a course of lectures in the observatory of Trinity College, which were very generally attended and greatly admired. In the year 1784 some circumstances occurred which made it desirable for him to discontinue his residence at Cambridge; and soon afterwards Mr Pitt, who had become acquainted with his merits by attending his lectures, bestowed on him a patent office, which required but little of his attendance, in order to have a claim on the employment of his mathematical abilities in a variety of financial calculations, to which he continued to devote a considerable portion of his time and attention throughout the remainder of his life.

The following, we believe, is a correct list of Mr Atwood's publications:—1. A Description of Experiments to illustrate a Course of Lectures; about 1775 or 1776, 8vo. 2. This work was reprinted, with additions, under the title of An Analysis of a Course of Lectures on the Principles of Natural Philosophy. Cambridge, 1784, 8vo. 3. A General Theory for the Mensuration of the Angle subtended by two objects, of which one is observed by rays after two reflections from plane surfaces, and the other by rays coming directly to the spectator's eye. Phil. Trans. 1781, p. 395. 4. A Treatise on the Rectilinear Motion and Rotation of Bodies, with a Description of Original Experiments relative to the subject. Cambridge, 1784, 8vo. 5. Investigations founded on the Theory of Motion for determining the Times of Vibration of Watch Balances. Phil. Trans. 1794, p. 119. 6. The Construction and Analysis of Geometrical Propositions, determining the positions assumed by homogeneous bodies, which float freely, and at rest, on a fluid's surface; also determining the Stability of Ships, and of other Floating Bodies. Phil. Trans. 1796, p. 46. 7. A Disquisition on the Stability of Ships. Phil. Trans. 1798, p. 201. 8. A Review of the Statutes and Ordinances of Assize which have been established in England from the 4th year of King John, 1202, to the 37th of his present Majesty. Lond. 1801, 4to. 9. A Dissertation on the Construction and Properties of Arches. Lond. 1801, 4to. 10. A Supplement to a Tract entitled a Treatise on the Construction and Properties of Arches, published in the year 1801; and containing Propositions for determining the Weights of the several Sections which constitute an Arch, inferred from the Angles. Also containing a Demonstration of the Angles of the several Sections, when they are inferred from the Weights thereof. To which is added, a Description of Original Experiments to verify and illustrate the Principles in this Treatise. With occasional Remarks on the Construction of an Iron Bridge of one Arch, proposed to be erected over the river Thames at London. Part II. By the author of the first part. Lond. 1804, 4to. Dated 24th November 1803. 11. A Treatise on Optics is mentioned by Nichols as having been partly printed by Bowyer in 1776, but never completed.

It may be very truly asserted that several of these works of Mr Atwood have materially contributed to the progress of science, by multiplying the modes of illustration which experimental exhibitions afford for the assistance of the instructor; at the same time they can scarcely be said to have extended very considerably the bounds of human knowledge, or to have demonstrated that their author was possessed of any extraordinary talent or energy of mind in overcoming great difficulties or in inventing new methods of reasoning. The *Analysis of a Course of Lectures* has been little read; and it bears evident marks of having been composed before Mr Atwood had acquired a habit of accurate reasoning on physical subjects. In the first page, for example, the forces of cohesion and gravitation are completely confounded; and in the third we find the idea of perfect spheres touching each other in a greater or less number of points, notwithstanding the appearance of precision which the author attempts to maintain in his language.

The object of the paper on *Reflection* is, to illustrate and improve the construction of Hadley's quadrant; and Mr Atwood proposes, for some particular purposes in practical astronomy, two new arrangements of the speculums, by which the rays are caused to move in different planes, and which he considers as affording greater accuracy for the measurement of small angles than the common form of the instrument, although not of general utility, nor very easily adjusted for observation.

The treatise on *Rectilinear Motion and Rotation* exhi-

Atwood.

Atwood. bits a good compendium of the elementary doctrines of mathematical mechanics; but it shows a great deficiency in the knowledge of the higher refinements which had been introduced into that science by Daniel Bernoulli, and Euler, and Lagrange. The properties of simply accelerated and retarded motion are first discussed, and the phenomena of penetration experimentally examined; the laws of varying forces are then investigated, and the properties of the pendulum demonstrated; the vibrations of an elastic chord are calculated, "considering the whole mass to be concentrated in the middle point," as an approximation; and then, instead of imitating and simplifying the elegant but complicated demonstrations of the continental mathematicians, the author most erroneously repeats, in the words of Dr Smith, the exploded doctrine, that "the string, during any instant of its vibration, will coincide with the harmonic curve." The subject of a resistance, varying as the square of the velocity, is next examined; and some useful experiments on the descent of bodies in water are stated in confirmation of the theory. On this occasion, the author observes, with regard to the formation of the different strata of the earth, that bodies disposed to break into large masses, though specifically lighter, may easily have descended more rapidly through a fluid, than denser but more brittle bodies, so that the natural order of densities may thus have become inverted. He next examines the theory of rotation, and relates some very interesting experiments on rectilinear and rotatory motions; and he shows that Emerson and Desaguliers were totally mistaken in asserting that "the momentum produced is always equal to the momentum which produces it." The last section of the work, which is devoted to the subject of free rotation, is the most elaborate of the whole; but it exhibits no material extension of the earlier investigations of the Bernoullis and Professor Vince; nor does it contain the important proposition of Segner, relating to the existence of three axes of permanent rotation, at right angles to each other, in every body, however irregular.

Notwithstanding these partial objections, the work may still, in many respects, be considered as classical. The paper on *Watch-balances* is principally intended to show the advantages which may be obtained, in Mr Mudge's construction, from the effect of subsidiary springs in rendering the vibrations isochronous, their actions being limited to certain portions of the arc of motion. If the author has here again omitted to follow the continental mathematicians in some of their refinements of calculation, it must be confessed that his view of the subject has, in this instance, not only the advantages of simplicity, but also that of a nearer approach to the true practical state of the question, than is to be found in the more complicated determinations which had been the result of the labours of some of his predecessors.

But, whatever may be the merits of these investigations, they appear to be far exceeded in importance by the papers on *Ships*, the first of which obtained for its author the honour of a Copleian medal. Its principal object is to show how much the stability of a ship will commonly vary, when her situation with respect to the horizon is materially altered; and how far the assumptions of theoretical writers, respecting many others of the forces concerned in naval architecture, will generally differ from the true state of these forces when they actually occur in seamanship. In the second part of the investigation, some errors of Bouguer and of Clairbois are pointed out; and the theoretical principles of stability are exemplified by a detailed calculation, adapted to the form and dimensions of a particular vessel, built for the service of the East India Company.

The latter years of our author's life do not appear to have been productive of any material advantage to science. His application to his accustomed pursuits was unremitting, but his health was gradually declining. He had no amusement except such as was afforded by the continued exercise of his mind, with a change of the object only; the laborious game of chess occupying, under the name of a recreation, the hours which he could spare from more productive exertions. He became paralytic some time before his death; and although he partially recovered his health, he did not live to complete his 62d year.

His researches concerning the history of the *Assize of Bread* must have required the employment of considerable diligence and some judgment in the discovery and selection of materials, although certainly the subject was not chosen for the purpose of affording a display of talent. His opinion respecting the operation of the assize, as favourable to the community, may by some be thought to be justified by the want of success which has hitherto attended the experiment on its suspension; but the advocates of that measure would certainly not admit the trial of a year to be sufficient for appreciating its utility.

The title-pages of the works on *Arches* explain the occasion on which they were brought forward, and at the same time exhibit a specimen of the want of order and precision which seems to have begun to prevail in the author's faculties; while the works themselves betray a neglect of the fundamental principles of mechanics, which is inconceivable in a person who had once reasoned with considerable accuracy on mathematical subjects. An anonymous critic, who is supposed to have been the late Professor Robison (*British Critic*, vol. xxi. January 1804), very decidedly, and at the same time very respectfully, asserted Mr Atwood's error in maintaining that there was no manner of necessity for the condition, that the general curve of equilibrium of an arch should pass through some part of every one of the joints by which it is divided; and in fact we may very easily be convinced of the truth of this principle, if we reflect that the curve of equilibrium is the true representative of the direction of all the forces acting upon each of the blocks, and that, if the whole pressure be anywhere directed to a point situated beyond the limit of the joint, there can be nothing whatever to prevent the rotation of the block on the end of the joint as a centre, until some new position of the block shall have altered the direction of the forces, or until the whole fabric be destroyed. The critic has also very truly remarked that the effects of friction have never been sufficiently considered in such arrangements; but a later author, in an anonymous publication, has removed a considerable part of this difficulty by showing that no other condition is required for determining these effects than that every joint should be perpendicular to the direction of the curve of equilibrium, either accurately or within the limit of a certain angle, which is constant for every substance of the same kind, and which he has termed the angle of repose. (L. L.)

AUBAGNE, a town of France, in the department of the Mouths of the Rhone, and arrondissement of Marseilles. It possesses manufactures of earthenware, and has a population of about 5000. It lies on the Veaine, 17 leagues N. W. of Aix.

AUBAINE, in the old customs of France, a right vested in the king, by virtue of which he claimed the inheritance of all foreigners that died within his dominions, notwithstanding any testamentary settlement made by the deceased. An ambassador was not subject to the right of aubaine; and the Swiss, Savoyards, Scots, and Portu-

Aubagne
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Aubaine.

Aube
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Aubusson. guese, were also exempted. This ancient privilege of the crown was abolished in 1819.

AUBE, a department of France, deriving its name from that of the chief river by which it is watered. It is bounded on the north by the department of the Marne, on the east by that of the Upper Marne, on the south-east by that of the Côte d'Or, on the south-west by that of the Yonne, and on the north-west by that of the Seine and the Marne. It extends over 2400 square miles or 1,536,000 acres, is tolerably productive in corn and wine, and breeds a considerable number of sheep. At the last census its inhabitants were 244,720, who work some iron mines, and manufacture silk, linen, and woollen goods, together with glass, paper, and leather. The department returns two deputies to the legislative assembly. It is divided into five arrondissements or circles. The chief city is Troyes.

AUBENTON, a small town of France, in the department of Aisne, situated on the river Aube. Long. 4. 30. E. Lat. 44. 37. N.

AUBETERRE, a small town of France, in the department of the Charente, nine leagues south of Angoulême.

AUBIGNY, or AVIGNY, a town of France, in the department of the Cher. It contains about 2500 inhabitants, who manufacture cloth, and carry on a trade in woollens, thread, linen, &c. Long. 2. 31. E. Lat. 47. 29. N.

AUBIN DE CORMIER, St, a town of France, in the department of the Ille and Vilaine, containing about 1500 inhabitants. It is situated six leagues N. E. of Rennes.

AUBONNE, a circle in the canton of Waadt or Vaud, in Switzerland, containing one town, four villages, and 6620 inhabitants. The capital of the circle is of the same name. It is small but well built, containing 1700 inhabitants, who make good wine, and pursue agriculture with skill.

AUBREY, JOHN, descended from an ancient family in Wiltshire, was born in 1626. He made the history and antiquities of England his peculiar study and delight, and contributed considerable assistance to the *Monasticon Anglicanum*. He succeeded to several good estates; but law-suits and other misfortunes consumed them all, and reduced him to absolute want. In this extremity he found a valuable benefactress in the Lady Long of Draycot in Wilts, who gave him an apartment in her house, and supported him till his death, which happened about the year 1700. He was a man of considerable ability, learning, and application, but credulous, and tinctured with superstition. He wrote *Miscellanies*, and *A Perambulation of the County of Surry*, in 5 vols. 8vo. Besides these, he left many pieces in manuscript, among which are *Monumenta Britannica*, or a Discourse concerning Stonehenge and Roll Rich Stones in Oxfordshire; and *Architectonica Sacra*, or a Dissertation concerning the Manner of Church Building in England. In 1813, his *Lives of Eminent Men*, and a *Collection of Letters*, were published from the originals preserved in the Bodleian library, in 3 vols. 8vo. The *Lives* are replete with curious matter; and that of Hobbes, in particular, is very full and elaborate.

AUBURG, a bailiwick on the Aue, belonging to Hesse till 1815, but then ceded to Hanover, and now included in the province Hoya and Diepholz of that kingdom. It is about 22 square miles or 14,000 acres in extent, but has no town, and only 274 houses, with 2309 inhabitants, who subsist by agriculture, and spinning and weaving coarse linen.

AUBURN, or ALBOURN, a market-town of Wiltshire, in England, about 70 miles from London.

AUBUSSON, an arrondissement in the department of the Creuse, in France. Its extent is 860 square miles, or 550,400 acres. It is divided into 10 cantons, and these into 113 communes, containing 93,298 inhabitants. The capital, of the same name, is a city on the banks of the river

Creuse, containing a population of 3520 persons, chiefly occupied with manufactures of silk, of carpets, and of cloths.

AUCH, one of the arrondissements of France, in the department of the Gers. It extends over 540 square miles, or 537,600 acres, and is divided into six cantons and 136 communes, containing 56,098 inhabitants. The chief city, of the same name, is situated on the river Gers. It contains a population of 9215 persons, mostly occupied in manufactures, viz. coarse woollens, serges, and leather.

AUCHTERARDER, a town and parish of Scotland, in the county of Perth. The town consists of a single street about a mile in length. It was formerly a royal burgh, but is now disfranchised. It has near it an ancient castle, said to have been a hunting seat of Malcolm Canmore. This place is 15 miles S. S. W. of Perth, and the population of the parish amounts to 2508.

AUCHTERMUCHTY, a town and parish of Scotland, in the county of Fife. The town has not the privilege of voting for a member of parliament, though it is governed by its own magistrates. A considerable manufacture of brown linen is carried on here. The population is 2404, and it is nine miles west from Cupar.

AUCKLAND-BISHOPS, a market-town in the ward of Darlington and county of Durham, 257 miles from London and 12 from the city of Durham. It stands on the banks of the river Wear, at its confluence with the Gaunless or Wandless. Its name is derived from the great number of oak-trees that formerly surrounded it, and from the palace belonging to the bishop of Durham. The town is remarkably well built. The parish church, a Gothic structure, is one mile from the town, at Auckland St Andrews. It has some manufactures of muslins and other cotton goods. The market is held on Thursday. The population in 1801 amounted to 1961, in 1811 to 2007, and in 1821 to 2180.

AUCTION, a kind of public sale, much in use for the disposal of household goods, books, plate, and other articles. By this method of sale the highest bidder is always the buyer. Auction was originally a kind of sale among the ancient Romans, performed by the public crier *sub hasta*, i. e. under a spear stuck up on the occasion by some magistrate, who made good the sale by delivery of the articles.

AUDE, a department of France, taking its name from the river, which rises in the Eastern Pyrenees, and runs through it in two branches to the Mediterranean Sea. It is bounded by the department of Hérault on the north-east, that of the Tarn on the north, by the Mediterranean on the east, and by the department of the Arriège on the west. Its extent is 2550 square miles, or 1,632,000 acres. It is divided into four circles, viz. Narbonne, Limoux, Carcassonne, and Castelnaudry; which are again divided into 31 cantons, and these subdivided into 436 communes or parishes. The inhabitants by the last census amounted to 262,190. The soil produces corn, fruit, wine, olives, and mulberry trees. The manufactures are of linen, woollen, and silk. The canal of Languedoc, which passes through the department, is highly beneficial to its trade. The chief city is Carcassonne. The department sends two members to the legislative assembly.

AUDEUS, the chief of the Audeans, obtained the name of a heretic, and the punishment of banishment, for celebrating Easter in the manner of the Jews, and attributing a human form to the Deity. He died in the country of the Goths, about the year 370.

AUDITOR, in a general sense, a hearer, or one who listens or attends to any thing.

AUDITOR of the Receipts is an officer of the exchequer who files the tellers' bills, makes an entry of them, and gives the lord treasurer a certificate of the money received.

Auch
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Auditor.

Auditors ed the week before. He also makes debentures to every teller before they receive any money, and takes their accounts.

Audran.

AUDITORS of the Revenue, or of the exchequer, officers who take the accounts of those who collect the revenues and taxes raised by parliament.

AUDITORS of the Prest and Imprest, officers of the exchequer, who received and made up the accounts of any money impressed to any man for the king's service. They received poundage on all accounts passed by them; but the office is now abolished.

AUDITORS, in *Ecclesiastical History*, those who formed one branch of the Manichean sect, which was divided into *elect* and *auditors*; corresponding, according to some writers, to *clergy* and *laity*, and according to others, to the *faithful* and *catechumens* among the Catholics. By the Manichean rule, a different course of life was prescribed to the elect from that of the auditors. The latter might eat flesh, drink wine, bathe, marry, traffic, possess estates, bear magistracy, and the like; all which were forbidden to the elect. The auditors were obliged to maintain the elect, and kneel down to ask their blessing. Beausobre observes that the elect were ecclesiastics, and in general those who made profession of observing certain counsels called *evangelic*, such as the clergy and monks; and they were called the *perfect* by Theodoret. The auditors were the laity, and so denominated because they heard in the church, whilst others taught and instructed.

AUDITORIUM, in the ancient churches, was that part of the church where the auditors stood to hear and be instructed.

AUDRAN, CLAUDE, a French engraver, the first of the celebrated artists of that name, was the son of Louis Audran, an officer belonging to the wolf-hunters in the reign of Henry IV. of France, and was born at Paris in 1592. He never made any great progress in that art, so that his prints are held in little or no estimation. Yet though he acquired no great reputation by his own works, it was no small honour to him to be the father of three great artists, Germain, Claude, and Girard; the last of whom has immortalized the name of the family. Claude Audran retired from Paris to Lyons, where he died in 1677.

AUDRAN, Carl, a very eminent engraver, was brother to the preceding, though some assert he was only his cousin-german, and was born at Paris in 1594. In his infancy he discovered a great taste and disposition for the arts; and to perfect himself in engraving, to which he appears to have been chiefly attached, he went to Rome, where he produced several prints which did him great honour. At his return he adopted that species of engraving which is performed with the graver only. He settled at Paris, where he died in 1674. The Abbé Marolles, who always speaks of this artist with great praise, attributes 130 prints to him; amongst which, the Annunciation, a middle-sized plate, upright, from Hannibal Caracci, and the Assumption, in a circle, from Domenichino, are the most esteemed. In the early part of his life he marked his prints with C, or the name of Carl, till his brother Claude published some plates with the initial only of his baptismal name, when, for distinction's sake, he used the letter K, or wrote his name Karl, with the K instead of the C.

AUDRAN, Germain, the eldest son of Claude, mentioned in the preceding article but one, was born in 1631, at Lyons, where his parents then resided. Not content with the instructions of his father, he went to Paris and perfected himself under his uncle Carl; so that, upon his return to Lyons, he published several prints which did great honour to his burin. His merit was in such esti-

mation that he was made a member of the academy established in that town, and chosen a professor. He died at Lyons in 1710, and left behind him four sons, all artists, namely, Claude, Benoit, John, and Louis.

Audran.

AUDRAN, Claude, the second of this name, and second son to Claude above mentioned, was born at Lyons in 1639, and went to Rome to study painting, where he succeeded so well that on his return he was employed by Le Brun to assist him in the Battles of Alexander, which he was then painting for the king of France. He was received into the Royal Academy in the year 1675, and died unmarried at Paris in 1684.

AUDRAN, Girard, or *Gerard*, the most celebrated artist of the whole family of the Audrans, was the third son of Claude Audran mentioned in a preceding article, and was born at Lyons in 1640. He was taught the first principles of design and engraving by his father; and, following the example of his brother, he went to Paris, where his genius soon began to manifest itself. His reputation there brought him to the knowledge of Le Brun, who employed him to engrave the Battles of Constantine, and the Triumph of that emperor; and for these works he obtained apartments at the Gobelins. At Rome, whither he went for improvement, he is said to have studied under Carlo Maratti, in order to perfect himself in drawing; and in that city, where he resided three years, he engraved several fine plates. That great encourager of the arts, M. Colbert, was so struck with the beauty of Audran's works whilst he resided at Rome, that he persuaded Louis XIV. to recall him. On his return he applied himself assiduously to engraving, and was appointed engraver to the king, from whom he received great encouragement. In the year 1681 he was named counsellor of the Royal Academy. He died at Paris in 1703, without male issue.

"He was," says the Abbé Fontenai, "the most celebrated engraver that ever existed in the historical line. We have several subjects which he engraved from his own designs, that manifested as much taste as character and facility. But in the Battles of Alexander he surpassed even the expectations of Le Brun himself." These consist of three very large prints, lengthwise, each consisting of four plates, which join together, from Le Brun; namely, The Passage of the Granicus, The Battle of Arbela, and Porus brought to Alexander after his defeat. To this set are added two more large prints lengthwise, on two plates each, also from Le Brun, namely, Alexander entering the Tent of Darius, and The Triumphal Entry of Alexander into Babylon. The former was engraved by Girard Edelinck, and the latter by Girard Audran. It is to be remarked of all these plates, that those impressions are generally most esteemed which have the name of Goyton the printer marked upon them. The Pest, from Peter Mignard, a large plate, lengthwise, also deserves particular notice. In the first impressions, the figure in the clouds is Juno with her peacock behind her; in the latter the peacock is obliterated, and the wings of an angel are added to the figure.

AUDRAN, Benoit, the second son of Germain Audran, was born at Lyons in 1661, where he learned the first principles of design and engraving under the instruction of his father. But soon after going to Paris, his uncle Girard Audran took him under his tuition; and Benoit so greatly profited by his instructions, that though he never equalled the sublime style of his tutor, yet he deservedly acquired great reputation. He was honoured with the appellation of the king's engraver, and received the royal pension in 1715. He was made an academician, and admitted into the council. He died unmarried at Louzouer, where he had an estate, in 1721. His manner was founded upon the bold clear style of his uncle. His

Audran outlines were firm and determined, his drawing correct, the heads of his figures in general very expressive, and the other extremities well marked.

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Augsburg.

AUDRAN, John, the third son of Germain Audran, was born at Lyons in 1667, and, after having received instructions from his father, went to Paris to perfect himself in the art of engraving under his uncle Gerard Audran. At the age of twenty years the genius of this great artist began to display itself in a surprising manner; and his subsequent success was such, that in 1707 he obtained the title of engraver to the king, and had a pension allowed him by his majesty, with apartments in the Gobelins; and the following year he was made a member of the Royal Academy. He was eighty years of age before he quitted the graver, and nearly ninety when he died at the apartments assigned him by the king. He left three sons behind, one of whom was also an engraver, as we shall see below. The best and most masterly prints of this artist are those which appear not so pleasing to the eye at first sight. In these the etching constitutes a great part; and he has finished them in a bold rough style.

AUDRAN, Louis, the last son of Germain Audran, was born at Lyons in 1670, and thence went to Paris, after the example of his brothers, to complete his studies in the school of his uncle Girard. He died suddenly at Paris in 1712, before he had produced any great number of prints by his own hand.

AUDRAN, Benoit, the second engraver of that name, was the son of John Audran, nephew to the former Benoit, and also established at Paris. He engraved but few plates. It is necessary, however, to be careful not to confound him with his uncle. But a little attention will easily prevent this mistake; for the second Benoit is vastly inferior to the first in point of merit. We have some few portraits by this artist; and, among other plates, the Descent from the Cross, from a picture of Poussin.

AUERBACH, a small city, with 1350 inhabitants, in the bailiwick of Eschenbach and circle of the Upper Maine, in the kingdom of Bavaria.

AUERBACH, a city on the river Golsch, with 1800 inhabitants, mostly weavers of cotton goods. It is in the bailiwick of Plauen and circle of Voigtland, in the kingdom of Saxony.

AUERSTADT, a village of 500 inhabitants, celebrated for the victory more commonly known by the name of the neighbouring city of Jena, which the French gained over the Prussians in October 1806. It is situated in the circle of Eckartsburg and government of Merseburg, in the Prussian province of Saxony.

AUGEAS, in fabulous history, was king of Elis, and particularly famed for his stable, which contained 3000 oxen, and had not been cleaned for thirty years. Hercules was desired to clear away the filth from this stable in one day; and Augeas promised, if he performed it, to give him a tenth part of the cattle. This task Hercules is said to have executed by turning the course of the river Alpheus through the stable; when Augeas refusing to stand by his engagement, Hercules slew him, and gave his kingdom to Phyleus his son, who had shown an abhorrence of his father's insincerity.

AUGRE, or **AWGRE**, an instrument used by carpenters and joiners to bore large round holes, and consisting of a wooden handle, and an iron blade terminated at bottom with a steel bit.

AUGSBURG, a city of Bavaria, the capital of the circle of the Upper Danube, celebrated in all the periods of German history. It is built on a beautiful plain between the rivers Lech and Wertach, and is surrounded with walls and ditches; but these form very imperfect defences against an enemy. The city is generally ill built, and most

of the streets are narrow; but the Max street is very magnificent, both for its breadth and the grandeur of the buildings. The public buildings especially are very noble edifices. The inhabitants amount to 28,900, of whom 16,800 are Catholics, and 12,060 Lutherans. The manufactures are respectable, and produce, though in diminished quantities, silver goods, linen, parchment, tobacco, leather, paper, silk goods, looking-glasses, soap, sealing-wax, and printed cottons. The commerce is still very respectable, as this city is the centre of communication between the south of Germany and Italy. Long. 11. 0. 14. E. Lat. 48. 21. 24. N.

Augsburg
Confession
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Augus-
tales.

AUGSBURG CONFESSION denotes a celebrated confession of faith drawn up by Luther and Melancthon, on behalf of themselves and other reformers, and presented in 1530 to the emperor Charles V. at the diet of Augusta or Augsburg, in the name of the evangelic body. This confession contains twenty-eight chapters, of which the greater part is employed in representing, with perspicuity and truth, the religious opinions of the Protestants, and the rest in pointing out the errors and abuses that occasioned their separation from the church of Rome.

AUGUR, an officer among the ancient Romans, appointed to foretell future events by the chattering, flight, and feeding of birds. There was a college or community of these functionaries, consisting originally of three members; afterwards the number was increased to nine, four of whom were patricians and five plebeians. They bore an augural staff or wand, as the ensign of their authority; and their dignity was so much respected that they were never deposed, nor any substituted in their place, even though convicted of the most enormous crimes.

AUGURY, in its proper sense, the art of foretelling future events by observations on birds; though it is used by some writers in a more general signification, as comprising all the different kinds of divination.

Augury was a very ancient superstition. We know from Hesiod that husbandry was in part regulated by the coming or going of birds; and most probably it had been in use long before his time, as astronomy was then in its infancy. In process of time these animals seem to have attained a greater and more wonderful authority, till at last no affair of consequence, either of public or private concern, was undertaken without consulting them. They were looked upon as the interpreters of the gods; and those who were qualified to understand their oracles were held among the chief men in the Greek and Roman states, and became the assessors of kings, and even of Jupiter himself.

AUGUST (*augustus*), in a general sense, something majestic, venerable, or sacred. The appellation was first conferred by the Roman senate upon Octavius, after he had been confirmed by them in the sovereign power.

AUGUST, in *Chronology*, the eighth month of our year, containing 31 days. August was dedicated to the honour of Augustus Cæsar, because in the same month he was created consul, thrice triumphed in Rome, subdued Egypt to the Roman empire, and made an end of the civil wars. It was previously called *Sextilis*, or the sixth month from March.

AUGUSTA, or **AUSTA**, an island in the Adriatic Sea, on the coast of Dalmatia, near Ragusa, subject to Venice. Long. 17. 50. E. Lat. 42. 35. N.

AUGUSTA, a city in the intendancy of Catania, in Sicily. It stands on a tongue of land near Cape Croce, and has a good harbour, from which some salt, honey, and wine are exported. It is well built and strongly fortified, and contains 1836 houses, with 9425 inhabitants. Long. 15. 13. 15. E. Lat. 37. 12. 50. N.

AUGUSTALES, in *Roman Antiquity*, an epithet given

Augustalia to the flamens or priests appointed to sacrifice to Augustus after his deification; and also to the *ludi* or games celebrated in honour of the same prince on the fourth of the ides of October.

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Augustine.

AUGUSTALIA, a festival instituted by the Romans in honour of Augustus Cæsar, on his return to Rome, after having settled peace in Sicily, Greece, Syria, Asia, and Parthia; on which occasion they likewise built an altar to him, inscribed *Fortunæ Reduci*.

AUGUSTALIS PRÆFECTUS, a title peculiar to a Roman magistrate who governed Egypt, with a power much like that of a proconsul in other provinces.

AUGUSTAN CONFESSION. See **AUGSBURG CONFESSION**.

AUGUSTENBURG, a ducal circle in the divisions of the Danish kingdom, known as the adlichen or noble districts. The duchy consists of seven parishes on the island of Alsen, and of one town and two villages on the continent. It is a part of the duchy of Sleswick.

AUGUSTIN, or **AUSTIN**, St, the first archbishop of Canterbury, was originally a monk in the convent of St Andrew at Rome, and educated under St Gregory, afterwards Pope Gregory I., by whom he was sent into Britain with forty other monks of the same order, about the year 596, to convert the English Saxons to Christianity. The missionaries landed in the isle of Thanet; and having sent some French interpreters to King Ethelbert with an account of their errand, the king gave them leave to convert as many of his subjects as they could, and assigned as their place of residence Durovernum, since called *Canterbury*, to which they were confined till the conversion of the king himself, whose example had a powerful influence in promoting the conversion of his subjects; but though he was extremely pleased at their becoming Christians, he never attempted to compel them. Augustin dispatched a priest and a monk to Rome, to acquaint the pope with the success of his mission, and to desire his resolution of certain questions. These men brought back with them a pall, and several books, vestments, utensils, and ornaments for the churches. His holiness, by the same messengers, gave Augustin directions concerning the settling of episcopal sees in Britain; and ordered him not to pull down the idol temples, but to convert them into Christian churches, only destroying the idols, and sprinkling the place with holy water, that the natives, by frequenting the temples they had been always accustomed to, might be the less shocked at their entrance into Christianity. Augustin resided principally at Canterbury, which thus became the metropolitan church of England; and having established bishops in several of the cities, he died on the 26th May 607. The Popish writers ascribe several miracles to him. The observation of the festival of St Augustin was first enjoined in a synod held under Cuthbert, archbishop of Canterbury, and afterwards by the pope's bull in the reign of King Edward III.

AUGUSTINE, St, an illustrious father of the church, was born at Thagaste, a city of Numidia, on the 13th of November 354. His father, a burgher of that city, was called *Patricius*, and his mother *Monica*, who being a woman of great virtue, instructed him in the principles of the Christian religion. In his early youth, while in the rank of the catechumens, he fell dangerously ill, and earnestly desired to be baptized; but the violence of the distemper ceasing, his baptism was delayed. His father, who had not yet been baptized, made him study at Thagaste, Madaura, and afterwards at Carthage. Augustine having read Cicero's books of philosophy, began to entertain a love for wisdom, and applied himself to the study of the Holy Scriptures; nevertheless, he suffered himself to be seduced by the Manicheans. At the age of nineteen he re-

turned to Thagaste, where he gave instructions in grammar, and also frequented the bar: he afterwards taught rhetoric at Carthage with applause. The insolence of the scholars at Carthage made him take a resolution to go to Rome, though against his mother's will. Here also he had many scholars; but disliking them, he quitted Rome, and settling at Milan, was chosen public professor of rhetoric in that city. Here he had opportunities of hearing the sermons of St Ambrose, which, together with the study of St Paul's epistles, and the conversion of two of his friends, determined him to retract his errors, and quit the sect of the Manicheans: this was in the thirty-second year of his age. In the vacation of the year 386 he retired to the house of a friend of his named Verecundus, where he seriously applied himself to the study of the Christian religion, in order to prepare himself for baptism, which he received at Easter in the year 387. Soon after this his mother came to see him at Milan, and invite him back to Carthage; but at Ostia, whither he went to embark in order to return, she died. He arrived in Africa about the end of the year 388; and having obtained a garden-plot without the walls of the city of Hippo, he associated himself with eleven other persons of eminent sanctity, who distinguished themselves by wearing leathern girdles, and lived there in a monastic way for the space of three years; exercising themselves in fasting, prayer, study, and meditation, day and night. Hence sprung the Augustine friars, or eremites of St Augustine, who were the first order of mendicants; those of St Jerome, the Carmelites, and others, being but branches of that of St Augustine. About this time, or before, Valerius, bishop of Hippo, ordained him priest much against his inclination: nevertheless he continued to reside in his little monastery with his brethren, who, renouncing all property, possessed their goods in common. Valerius, who had appointed St Augustine to preach in his place, allowed him to do it in his presence, contrary to the custom of the churches in Africa. He explained the creed in a general council of Africa held in 393. Two years after, Valerius, fearing he might be preferred to be bishop of another church, appointed him his coadjutor or colleague, and caused him to be ordained bishop of Hippo, by Megalulus, bishop of Calame, then primate of Numidia. St Augustine died on the 28th of August 430, aged seventy-six years; having had the misfortune to see his country invaded by the Vandals, and the city where he was bishop besieged for seven months. The works of St Augustine extend to ten volumes: the best edition of them is that of Maurin, printed at Antwerp in 1700.

AUGUSTINE, St, a fort of North America, on the east coast of Cape Florida, situated in Long. 81. 40. W. Lat. 30. 0. N.

AUGUSTINE, a cape of South America. Long. 35. 11. W. Lat. 8. 38. S.

AUGUSTINS, or **AUGUSTINIANS**, an order of religious, thus called from St Augustine, whose rule they observe. The Augustins, popularly also called Austin friars, were originally hermits, whom Pope Alexander IV. first congregated into one body, under their general Lanfranc, in 1256. Soon after their institution this order was brought into England, where they had about thirty-two houses at the time of their suppression. The Augustins are clothed in black, and make one of the four orders of mendicants.

AUGUSTOW, a woiwodship of Poland, which takes its name from the city which is its capital. The woiwodship is the northernmost part of the kingdom, a long strip, extending from the Bug to the Niemen, between long. 21. 20. and 23. 9. E. and lat. 52. 40. and 55. 5. N. Its extent is 6870 square miles, and it incloses the greater portion of the lakes of Poland, and many districts of extensive woods; but it has some patches of good arable

Augustine
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Augustow.

Augustow land. It is divided into five obwods or circles, and contains 335,000 inhabitants.

Aulic.

AUGUSTOW, a circle or obwod in the woiwodship of the same name in Poland, formed out of the ancient circles of Sonion and Bober. It extends over 1515 square miles, and contains about 75,000 inhabitants.

AUGUSTOW, a city, the capital of the woiwodship of that name, on the river Netta, near an extensive lake. It contains 1980 inhabitants, of whom one quarter are Jews, who have much trade with Russia in horses and cattle. It is situated in long. 22. 53. 10. E. and lat. 53. 49. 30. N.

AUGUSTUS, FORT, a small fortress seated on a plain at the head of Loch Ness, in Scotland, between the rivers Tarf and Oich.

AUGUSTUS, the appellation conferred upon Cæsar Octavianus, the first Roman emperor. The obscure name *Octavianus*, Mr Gibbon observes, he derived from a mean family in the little town of Aricia. It was stained with the blood of the proscription; and he was desirous, had it been possible, to erase all memory of his former life. The illustrious surname of Cæsar he had assumed, as the adopted son of the dictator; but he had too much good sense either to hope to be confounded, or to wish to be compared, with that extraordinary man. It was proposed in the senate to dignify their minister with a new appellation; and, after a very serious discussion, that of Augustus was chosen from among several others, as being the most expressive of the character of peace and sanctity which he uniformly affected. Augustus was therefore a personal, Cæsar a family, distinction. The former should naturally have expired with the prince on whom it was bestowed; and, however the latter was diffused by adoption and female alliance, Nero was the last prince who could allege any hereditary claim to the honours of the Julian line. But at the time of his death the practice of a century had inseparably connected those appellations with the imperial dignity, and they have been preserved by a long succession of emperors, Romans, Greeks, Franks, and Germans, from the fall of the republic to the present time. A distinction was, however, soon introduced. The sacred title of Augustus was always reserved for the monarch; the name of Cæsar was more freely communicated to his relations, and, from the reign of Hadrian at least, became appropriated to the second person in the state, who was considered the presumptive heir of the empire.

AUK. See ORNITHOLOGY.

AULA is used by Spelman for a court-baron; by some old ecclesiastical writers for the nave of a church, and sometimes for a court-yard.

AULA Regia, or Regis, a court established by William the Conqueror in his own hall, composed of the king's great officers of state, who resided in his palace, and were usually attendant on his person. This court was regulated by the article which forms the eleventh chapter of Magna Charta, and was established in Westminster Hall, where it has ever since continued.

AULCESTER, a market-town in the county of Warwick, distant 103 miles from London and 14 from Warwick. It stands at the junction of the two rivers Alne and Arrow. It was formerly a place of more importance, and the residence of some of our monarchs in remote periods. It still has a church, which is a fine Gothic structure. The market is held on Tuesday. The population amounted in 1801 to 1625, in 1811 to 1862, and in 1821 to 2229.

AULETES, in *Antiquity*, denotes a flute-player. One of the Ptolemies, kings of Egypt, father of Cleopatra, bore the surname or denomination of *Auletes*.

AULIC, an epithet given to certain officers of the empire, who compose a court which decides, without appeal, in all processes entered in or submitted to it.

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AULIC, in the Sorbonne and foreign universities, is an act which a young divine maintains upon being admitted a doctor of divinity. It begins by a harangue of the chancellor, addressed to the young doctor, after which he receives the cap, and presides at the aulic or disputation.

AULPS, a city on the river Braque, with 2947 inhabitants, in the arrondissement of Draguignan, in the department of the Var, in France.

AULUS GELLIUS. See GELLIUS.

AUMBRY, a country word denoting a cupboard.

AUME, a Dutch measure for Rhenish wine, containing 40 English gallons.

AUNCEL WEIGHT, an ancient kind of balance, now out of use, being prohibited by several statutes, on account of the many deceits practised by it. It consisted of scales hanging on hooks, fastened at each end of a beam, which a man lifted up on his hand. In many parts of England auncel weight signifies meat sold by the hand, without scales.

AUNE, a long measure used in France to measure cloths, stuffs, ribbons, &c. At Rouen it is equal to one English ell, at Calais to 1.52, at Lyons to 1.061, and at Paris to 0.95.

AUNGERVYLE, RICHARD, commonly known by the name of *Richard de Bury*, was born in 1281, at St Edmund's Bury, in Suffolk, and educated at the University of Oxford; after which he entered into the order of Benedictine monks, and became tutor to Edward prince of Wales, afterwards King Edward III. Upon the accession of his royal pupil to the throne, he was first appointed cofferer; then treasurer of the wardrobe, archdean of Northampton, prebendary of Lincoln, Sarum, and Lichfield, keeper of the privy seal, dean of Wells; and last of all he was promoted to the bishopric of Durham. He likewise enjoyed the offices of lord high chancellor and treasurer of England, and discharged two important embassies at the court of France. Learned himself, and a patron of the learned, he maintained a correspondence with some of the greatest geniuses of the age, particularly with the celebrated Italian poet Petrarch. He was also of a most humane and benevolent temper, and performed many signal acts of charity. Every week he caused eight quarters of wheat to be made into bread, and given to the poor. Whenever he travelled between Durham and Newcastle, he distributed eight pounds sterling in alms; between Durham and Stockton five pounds; between Durham and Auckland five marks; and between Durham and Middleham five pounds. He founded a public library at Oxford for the use of the students, which he furnished with the best collection of books then in England; and appointed five keepers, to whom he granted yearly salaries. At the dissolution of religious houses in the reign of Henry VIII. Durham College, where he had fixed the library, being dissolved among the rest, some of the books were removed to the public library, some to Baliol College, and some came into the hands of Dr George Owen, a physician of Godstow, who bought that college of King Edward VI. Bishop Aungervyle died at his manor of Auckland, 24th April 1345, and was buried in the south part of the cross aisle of the cathedral church of Durham, to which he had been a benefactor. He wrote, 1. *Philobiblos*, containing directions for the management of his library at Oxford, and a great deal in praise of learning, but in very bad Latin. 2. *Epistolæ Familiarium*; some of which are addressed to Petrarch. 3. *Orationes ad Principes*; mentioned by Bale and Pitts.

AUNIS, formerly a small province in France, but now included in the department of the Lower Charente, and belonging to the arrondissements of Rochefort, La Rochelle, and Varennes.

Aulic
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Aunis.

Aurach
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Aurillac.

AURACH, a town of Germany, with a good castle, in the kingdom of Wirtemberg.

AURÆ, in *Mythology*, a name given by the Romans to the nymphs of the air. They are mostly to be found in the ancient paintings of ceilings, where they are represented as light and airy, generally with long robes and flying veils of some lively colour or other, and fluttering about in the rare and pleasing element assigned to them. They are characterized as sportive and happy in themselves, and as well-wishers to mankind.

AURAY, a small seaport town of Lower Brittany, in France, situated on the gulf called Morbihan, and in the department of the same name. It consists of only one handsome street, and is chiefly known for its trade. Long. 2. 25. W. Lat. 47. 48. N.

AURELIA, in *Natural History*, the same with what is more usually called *chrysalis*, and sometimes *nymph*. See ENTOMOLOGY.

AURELIANUS, LUCIUS DOMITIUS, emperor of Rome, commanded the armies of the emperor Claudius with such glory, that after the death of that emperor all the legions agreed to place him on the throne. This happened in the year 270. He defeated the Goths, Samaritans, Marcomanni, the Persians, Egyptians, and Vandals, and conquered Zenobia queen of the Palmyrenians, and Tetricus general of the Gauls, both of whom were compelled to grace his triumph in the year 274. He was killed by one of his generals in Thrace in the year 276, when he was preparing to enter Persia with a great army.

AURELIUS VICTOR. See VICTOR.

AUREOLA, in its original signification, signifies a jewel, which is proposed as a reward of victory in some public dispute. Hence the Roman schoolmen applied it to denote the reward bestowed on martyrs, virgins, and doctors, on account of their works of supererogation; and painters use it to signify the crown of glory with which they adorn the heads of saints, confessors, and martyrs.

AUREUS, a Roman gold coin, equal in value to 25 denarii. According to Ainsworth, the aureus of the higher empire weighed near five pennyweights, and in the lower empire little more than half that weight. We learn from Suetonius that it was customary to give aurei to the victors in the chariot races.

AURICH, a bailiwick in the Hanoverian province of East Friesland, which contains, in one city and 23 villages, 3950 houses and 20,087 inhabitants. The extent is 270 square miles, or 172,800 acres. The land is marshy, but there are some good meadows. The capital of the bailiwick is of the same name, containing 2660 inhabitants, who, by means of a canal to the Ems, carry on some trade in pipes, tobacco, paper, and corn spirits. It is situated in long. 7. 33. 11. E. and lat. 53. 28. 17. N.

AURICLE, in *Anatomy*, that part of the ear which is prominent from the head, called by many authors *auris externa*. Auricles are likewise two muscular bags situated at the basis of the heart, and intended as diverticula for the blood during the diastole.

AURIFLAMMA, in the French history, properly denotes a flag or standard belonging to the Abbey of St Denis, suspended over the tomb of that saint, which the religious, on occasion of any war in defence of their lands or rights, took down with great ceremony, and gave to their protector or advocate, to be borne at the head of their forces. Auriflamma is also sometimes used to denote the chief flag or standard in any army.

AURIGA, the WAGGONER, in *Astronomy*, a constellation of the northern hemisphere. It contains, in Bode's catalogue, 261 stars. Capella, a well-known, beautiful, double star, is in this constellation.

AURILLAC, an arrondissement in the department of

the Cantal, in France, extending over 796 square miles, or 509,440 acres. It is divided into eight cantons, and these into 94 communes, containing 90,576 inhabitants. The chief city of the same name stands on the river Jordone, and contains 10,333 inhabitants, employed in making woollen stuffs, lace, and carpets.

AURIOL'S ISLAND, one of the Aladin Islands, on the east side of the Bay of Bengal, about 12 miles in circumference. Lat. 9. 22. N.

AURISCALPIUM, an instrument to clean the ears, and serving also for other operations in disorders of that part.

AURORA, the morning twilight, or that faint light which appears in the morning when the sun is within 18 degrees of the horizon.

AURORA, the goddess of the morning, according to the Pagan mythology. She was the daughter of Hyperion and Theia, according to Hesiod, but of Titan and Terra, according to others. It was under this name that the ancients deified the light which foreruns the rising of the sun above our hemisphere. The poets represent her as rising out of the ocean in a chariot, with rosy fingers dropping gentle dew. Virgil describes her ascending in a flame-coloured chariot with four horses.

AURORA, one of the New Hebrides Islands in the South Sea, in which Mr Forster supposes the *Peak d'Etoile* mentioned by Mr Bougainville to be situated. It is about 12 leagues long, but not above five miles broad in any part; and it stretches nearly north and south. The middle lies in lat. 15. 6. S. long. 168. 24. E.

AURORA BOREALIS, *Polar Light*, *Northern Lights*, or *Streamers*, is a beautifully luminous meteor, appearing in the form of beams or rays, and sometimes in that of arches or crowns. The rays are seldom stationary, generally flitting with greater or less velocity throughout the heavens; the arches are sometimes single; sometimes several concentric ones are seen. These lights, or meteoric coruscations, are most brilliant in the arctic regions, appearing mostly in the winter season and in frosty weather. In the Shetland Islands, the *merry dancers*, as they are there and elsewhere called, are the constant attendants of clear evenings, and serve to diminish materially the gloom of the long winter nights. They commonly appear at twilight near the horizon, and sometimes continue in that state for several hours without any sensible motion; after which they send forth streams of stronger light, which rise from the horizon in a pyramidal undulating form, shooting with great velocity up to the zenith, assuming columnar and other shapes, and varying in colour from a reddish yellow to the darkest russet. At other times they cover the whole hemisphere with their flickering and fantastical coruscations. On these occasions their motions are amazingly quick, and they astonish the spectator with rapid changes of form. They break out in places where none were seen before, skimming briskly along the heavens; then they are suddenly extinguished, leaving behind a uniform dusky track, which, again, is brilliantly illuminated in the same manner, and as suddenly left a dull blank. Some nights they assume the appearance of vast columns; exhibiting on one side tints of the deepest yellow, and on the other melting away till they become undistinguishable from the surrounding sky. They have generally a strong tremulous motion from end to end, which continues till the whole vanishes. According to the state of the atmosphere, their colours vary. They sometimes assume the hue of blood, on which occasion their appearance is considered portentous. Then the rustic sages become prophetic, and terrify the gazing spectators with the dread of war, pestilence, and famine. This superstition is not peculiar to the northern islands; nor are these appearances of recent date. The

Auriol's
Island
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Aurora
Borealis.

Aurora
Borealis.
Formerly
rare.

ancients called them *chasmata*, and *trabes*, and *bolides*, according to their forms or colours.

In early times, it is said, these meteoric lights were extremely rare, and on that account were the more taken notice of. From the days of Plutarch to those of our sage historian Sir Richard Baker, they were supposed to portend great events, and lively imaginations shaped them into aerial conflicts :

Fierce fiery warriors fight upon the clouds,
In ranks, and squadrons, and right form of war.

Dr Halley tells us, that when he observed a great aurora borealis in 1716, he had begun to despair of ever seeing one at all ; none having appeared, at least of any considerable extent, from the time he was born until then. But notwithstanding this long interval, it seems that, in some periods, the aurora borealis had been seen much more frequently ; and perhaps this, as well as many other natural phenomena, may be subject to periodical changes and variations.

History. The only thing resembling a distinct history of this phenomenon is that which has been given by the learned Dr Halley, in the *Philosophical Transactions*, No. 347. The first account he gives is of the appearance of what is called by him *burning spears*, which were seen at London on the 30th January 1560. This account is taken from a book entitled *A Description of Meteors*, by W. F. D.D., reprinted at London in 1654. The next appearance, according to the testimony of Stow, was on the 7th October 1564. In 1574 also, according to Camden, and Stow above-mentioned, an aurora borealis was observed two nights successively, viz. on the 14th and 15th of November, having much the same appearances as that described by Dr Halley in 1716, and which we now so frequently observe. Again, an aurora was twice seen in Brabant, in the year 1575, viz. on the 13th of February and 28th of September. Its appearances at both these times were described by Cornelius Gemm, professor of medicine in the university of Louvain, who compares them to spears, fortified cities, and armies fighting in the air. After this, Michael Mæstlin, tutor to the great Kepler, assures us, that at Baknang in the county of Wurtemberg in Germany, these phenomena, which he styles *chasmata*, were seen by himself no less than seven times in 1580. In 1581 they again appeared, in an extraordinary manner in April and September, and in a less degree at some other periods of the same year. In September 1621, a similar phenomenon was observed all over France, and described by Gassendus, who gave it the name of *aurora borealis* ; yet neither this, nor any similar appearance posterior to 1574, is described by English writers till the year 1707, which, as Dr Halley observes, shows the prodigious neglect of curious matters that then prevailed. From 1621 to 1707, indeed, there is no mention made of an aurora borealis having been seen by any body ; and, considering the number of astronomers who during that period were in a manner continually poring over the heavens, we may very reasonably conclude that nothing of the kind really made its appearance until after an interval of eighty-six years. A small one was seen in November 1707 ; and during that and the following year, the same appearances were repeated five times. The next on record is that mentioned by Dr Halley in March 1716, which from its brilliancy attracted universal attention, and was considered by the vulgar as marking the introduction of a foreign race of princes. Since that time these meteors have been much more frequent. Many of those observed in this island have been described. The following account of a splendid aurora borealis, as seen from the Gosport Observatory on the 7th January 1831, will give an idea of the brilliancy of this meteor, and of its colours, lustres, arches, and beams.

“ In the afternoon of this day there was a peculiar brightness in the atmosphere near the horizon, for several degrees on each side of the true north point, which indicated the approach of an aurora ; indeed we have reason to suspect that it was a faint appearance of one ; while the sun shone in all his splendour, without the interposition of cloud or vapour. Shortly after sunset an aurora borealis gradually rose above the northern horizon, and at a quarter past five o'clock it had assumed the form of an arch of refulgent light, ten degrees in height, and seventy degrees in width. From this time till half-past five it continued to increase in the intensity of its light, expanding to the western point of the horizon, and fifty-five degrees to the eastward of north, which made the chord of the aurora a hundred and fifty-five degrees. Now, a bright *flame-coloured* rainbow-like arch, between three and four degrees broad, and pretty well defined at its upper edge, emanated from the curved edge of the aurora to an altitude of thirty-five degrees ; and while it remained apparently stationary, a beautiful rainbow-like arch, still more brilliant, formed about ten degrees south of the zenith, by streamers suddenly springing up from the N. E. by E. and W. by S. points of the horizon, and meeting in the zenith, so that these two bows presented themselves at the same time. At thirty-five minutes past five, the latter bow, in some parts four and in others six degrees in width, divided a little to the eastward of its vertex ; and the long streamers which formed it passed off gently to the southward in very bright patches, two in the south-east and one in the south-west quarters, like luminous clouds, and continued in sight nearly a quarter of an hour. One of these bright patches nearly covered Orion several minutes. At forty minutes past five another rainbow-like arch, equally wide and bright, was formed by long streamers from about the same points of the horizon, whose point of convergence was the same, and its course through the feet of Gemini, near the Pleiades, through Aries, the square of Pegasus, the head of Equuleus, and the bow of Antinous. It passed off gradually towards the south ; and at a quarter before six the planet Mars, then near the meridian, and about forty-five degrees in altitude, rested, as it were, conspicuously on it. At six it had gone far towards the southern horizon, and could scarcely be perceived, leaving the sky unusually clear and bright. By this time the bow over the aurora had much increased in altitude, and was nearly effaced.

“ At a few minutes past six, after a great many coloured columns of light had risen from the north-east and north-west quarters, and passed the zenith, the aurora sunk considerably towards the horizon ; but its upper edge remained bright and very well defined. Some of the streamers or columns were long, others short, and the widest generally remained long enough to pass through a gradation of prismatic colours. At half-past six the aurora again increased in altitude, and vivid coruscations radiated from every part of its arch, and, on intermixing with each other, formed wide columns, which were so grand with crimson tints as to astonish every spectator. Between seven and eight the aurora had spread at least two thirds over the heavens, and as far as the shoulders of Orion on the eastern side of the meridian, when large perpendicular columns, and short pointed luminous coruscations, rising from the aurora, glittering like spears and conical points in nearly parallel rows, now mixing and then dividing, all passed through red, orange, lake, crimson, green, and purple tints ; so that the appearance altogether over so great an extent of the heavens was exceedingly grand, particularly when contrasted with the cerulean sky, and its spangled constellations, in the southern portion of the hemisphere.

Aurora
Borealis.
Aurora
borealis of
Gosport.

Aurora
Borealis.

"At ten minutes before eight the aurora was in its greatest splendour. At five minutes before eight another luminous rainbow-like arch stretched across the heavens from the eastern point of the horizon, and displayed several prismatic colours while passing southward. Soon after eight a large dark space, in and near the horizon, presented itself several degrees on each side of the magnetic north, and the aurora, still far over the heavens, gradually diminished. At nine it again ascended, and wide columns rose from every part of its arch, and passed through the same colours as before-mentioned. Between nine and ten the magnetic needle, which in the early part of the evening stood at twenty-four degrees west of the true north, was disturbed, and receded upwards of half a degree northward, either by the influence of the aurora, or by a change of wind from north-east to south-west, and of course a change in its electrical state. At a quarter before eleven there was a grand display of about twelve or fourteen glowing columns from the aurora, several of which passed beyond the zenith, when a perfect red rainbow-like arch, ten degrees above the aurora, was visible. At eleven another bow three degrees and a half wide rose from the aurora, and passed through Aries, Cassiopeia, Ursa Minor, and the square of Ursa Major, until, reaching the zenith, it gradually disappeared. At half-past eleven the aurora again began to sink slowly, and did not rise afterwards. At five minutes before twelve, a large brilliant meteor, the only one observed through the night, passed under Ursa Major. At one o'clock A.M. the highest part of the aurora, about the magnetic north, had sunk to within six or seven degrees of the horizon; yet bright coruscations occasionally emanated from it till two, when the observations were discontinued, as no more interesting meteoric appearances were likely to occur."

Aurora
Cumber-
land
House.

The auroras observed, one at Cumberland House and another at Fort Enterprize, in North America, are described by Lieutenant Hood, in Captain Franklin's *Narrative*. The account of the former is as follows:—

"For the sake of perspicuity," says Mr Hood, "I shall describe the several parts of the aurora observed at Cumberland House, which I term *beams*, *flashes*, and *arches*. The *beams* are little conical pencils of light, ranged in parallel lines, with their pointed extremities towards the earth, generally in the direction of the dipping needle. The *flashes* seem to be scattered beams, approaching nearer to the earth, because they are similarly shaped, and infinitely larger. I have called them flashes, because their appearance is sudden, and seldom continues long. When the aurora first becomes visible, it is formed like a rainbow, the light of which is faint, and the motion of the beams undistinguishable. It is then in the horizon. As it approaches the zenith, it resolves itself at intervals into beams, which, by a quick undulating motion, project themselves into wreaths, afterwards fading away, and again brightening, without any visible expansion or concentration of matter. Numerous flashes are seen in different parts of the sky. That this mass, from its short distance above the earth, would appear like an *arch* to a person situated at the horizon, may be demonstrated by the rules of perspective, supposing its parts to be nearly equidistant from the earth. An undeniable proof of it, however, is afforded by the observations of the 6th and 7th of April, when the aurora, which filled the sky at Cumberland House, from the northern horizon to the zenith, with wreaths and flashes, assumed the shape of arches at some distance to the southward.

"But the aurora does not always make its first appearance as an arch. It sometimes rises from a confused mass of light in the east or west, and crosses the sky towards

the opposite point, exhibiting wreaths of beams, or *coronæ boreales*, in its way. An arch, also, which is pale and uniform at the horizon, passes the zenith without displaying any irregularity or additional brilliancy; and we have seen three arches together very near the northern horizon, one of which exhibited beams, and even colours; but the other two were faint and uniform. On the 7th of April an *arch* was visible to the southward, exactly similar to that in the north, and it disappeared in fifteen minutes. It had probably passed the zenith before sunset. The motion of the whole body of aurora is from the northward to the southward, at angles not more than twenty degrees from the magnetic meridian. The centres of the arches were as often in the magnetic as in the true meridian.

"The *colours* do not seem to depend on the presence of any luminary, but to be generated by the motion of the beams, and then only when that motion is rapid, and the light brilliant. The lower extremities quiver with a *fiery red colour*, and the upper with *orange*. We once saw *violet* in the former. The number of auroræ visible in September was two, in October three, in November three, in December five, in January five, in February seven, in March sixteen, in April fifteen, and in May eleven. Calm and clear weather was the most favourable for observation; but it is discernible in cloudy weather, and through mists. We could not perceive that it affected the weather. The magnetic needle, in the open air, was disturbed by the aurora, whenever it approached the zenith. Its motion was not vibratory, as observed by Mr Dalton; and this was, perhaps, owing to the weight of the card attached to it. It moved slowly to the east or west of the magnetic meridian, and seldom recovered its original direction in less than eight or nine hours. The greatest extent of its aberration was 45°. A delicate electrometer, suspended at the height of fifty feet from the ground, was never perceptibly affected by the aurora; nor could we distinguish its rustling noise, of which, however, such strong testimony has been given to us, that no doubt can remain of the fact."

The account of the aurora observed at Fort Enterprize is also interesting and instructive with reference to the theory of the phenomenon.

Aurora of
Fort En-
terprize.

"The shapes of the aurora observed at Fort Enterprize, at its entry into the horizon, and progress through the sky, may be reduced under two general descriptions. In the first I shall class those which are formed like rainbows or arches in the earliest stage of their appearance. They rise with their centres sometimes in the magnetic meridian, and sometimes several degrees to the eastward or westward of it. The number visible at the same time seldom exceeds five, and is seldom limited to one. The altitude of the lowest, when first seen, is never less than four degrees. As they advance towards the zenith, their centres (or the parts most elevated) preserve a course nearly in the magnetic meridian, or parallel to it. But the eastern and western extremities vary their respective distances, and the arches become irregularly broad streams in the zenith, each dividing the sky into two unequal parts, but never crossing one another till they separate into parts. Those arches which were bright at the horizon increase their brilliancy in the zenith, and discover the beams of which they are composed when the interior motion is rapid. This interior motion is a sudden glow, not proceeding from any visible concentration of matter, but bursting out in several parts of the arch, as if an ignition of combustible matter had taken place, and spreading itself rapidly towards each extremity. In this motion the beams are formed, such as are described in the preceding observations upon the subject. They have two motions; one at right angles to their length or sideways; and the other a tremulous

Aurora
Borealis.

and short vibration, in which they do not exactly preserve their parallelism to each other. By the first they project themselves into wreaths, serpentine forms, or irregular broken curves. The wreaths, when in the zenith, present the appearance of coronæ boreales. The second motion is always accompanied with colours; for it must be observed, that beams are often formed without any exhibition of colours; and I have not, in that case, perceived the vibratory motion. The beams, in different auroræ, and sometimes in the same, are of different magnitudes, arising, probably, from their various distances. These evolutions, often repeated, destroy the shape and coherence of the several arches, though they doubtless retain the arched appearance to the eye of a spectator at the southern horizon; for it would be absurd to suppose that these changes occur only in the zenith of one particular place. The observations at different places in 1820 afford satisfactory proof to the contrary; and the number of arches often increased or diminished in their advance to the zenith, by a dismemberment of which, from their distance, we could not distinguish the particulars. However, their several parts passed gradually to the southward, where they assumed the form of an arch. They are also sometimes distributed into flashes, and other detached portions, which pass to the south-eastward. The revolution of an arch from north to south occupies a space of time varying from twenty minutes to two hours. At Cumberland House, the arches were in many instances almost stationary for several hours, a proof that if their motion was not slower, their distance from the earth was greater, than at Fort Enterprize. The arches, which are faint at the horizon, very frequently pass the zenith without any increase of brilliancy or apparent internal motion.

“The second general class of auroræ are those which propagate themselves from different points of the compass, between north and west towards the opposite points; sometimes also originating in the south-east quarter, and extending themselves towards the north-west. They may be subdivided, like the former, into the distant arches which pass to the southward without much visible change in their appearance, and those which discover beams, and separate at intervals into wreaths, flashes, and irregular segments, exhibiting all the phenomena described above. In explaining the mode by which the two general classes of auroræ are conducted into the horizon, I shall call the motion of the arches, which is in a plane seldom deviating more than two points from the magnetic meridian, the direct motion; and that by which the auroræ propagate themselves nearly at right angles to the magnetic meridian, the lateral motion. Let us suppose a mass of auroræ to be modelled at its birth in a longitudinal form, crossing the meridians at various angles, the whole to be impelled with a direct motion towards the magnetic south, but the parts having different velocities, and each extremity continually removing itself by a lateral motion from the centre, so as to increase the length of the mass. If the centre enter the northern horizon, it will appear like an arch, the real extremities being invisible; and its direct motion will carry it to the southward in that form. But if one extremity first enter the horizon, it will extend itself by its lateral motion to the opposite point, passing, at the same time, by its direct motion to the southward. Of the unequal velocities of the parts, we had many instances, in the direct motion of the arches, by which the centres were often carried from the zenith sixty or seventy degrees to the southward, while the extremities did not materially alter their positions. Nor can this be accounted for by any application of the rules of perspective, because arches exactly similar sometimes changed the bearings of their extremities in proportion to the advance of their

centres; and at Cumberland House, on two occasions, the extremities of arches arrived at the east and west points of the compass, while their centres remained only ten degrees above the northern horizon.”

It was for a long time matter of doubt whether this meteor made its appearance only in the northern hemisphere, or whether it was also to be observed near the south pole. But the occurrence of the aurora in the antarctic regions was clearly ascertained by Mr Forster, who, in his voyage round the world with Captain Cook, observed it in the high southern latitudes, though with phenomena somewhat different from those which are seen here. On the 17th February 1773, when the navigators were in latitude 58° south, “a beautiful phenomenon was observed,” says Mr Forster, “during the preceding night, which appeared again this and several following nights. It consisted of long columns of a clear white light, shooting up from the horizon to the eastward, almost to the zenith, and gradually spreading on the whole southern part of the sky. These columns were sometimes bent sidewise at their upper extremities; and though in most respects similar to the northern lights (*aurora borealis*) of our hemisphere, yet differed from them in being always of a whitish colour, whereas ours assume various tints, especially those of a fiery and purple hue. The sky was generally clear when they appeared, and the air sharp and cold, the thermometer standing at the freezing point.” The accounts of subsequent navigators, particularly Weddell, though given more in detail, differ in no material respect from that just quoted, and therefore need not be cited at length. They prove that this splendid meteor is not confined to the northern, but occurs also in the southern regions of the globe, though with considerable diversity in the accompanying phenomena.

Colour.—The colours of the polar lights are of various tints. The *rays* or *beams* are steel gray, yellowish gray, pea-green, celandine green, gold yellow, violet blue, purple, sometimes rose red, crimson red, blood red, greenish red, orange red, and lake red. Some of the beams appear as if tinged with black, and resemble dense columns of smoke. The *arches* are sometimes nearly black, passing into violet blue, gray, gold yellow, or white bounded by an edge of yellow. The colours are also sometimes vivid and prismatic. Maupertuis describes a very remarkable red-coloured polar light which he saw at Osver Zornea on the 18th December 1786. An extensive region of the heavens towards the south appeared tinged of so lively a red, that the whole constellation Orion seemed as if dyed in blood. The light was for some time fixed, but soon became movable; and after having successively assumed all the tints of violet and blue, it formed a dome, of which the summit approached the zenith in the south-west. Its splendour was so great as to be in no degree affected by the bright light of the moon. Maupertuis adds, that he observed only two of these northern lights in Lapland, which are of very rare occurrence in that country, although the aurora there assumes a great variety of tints; hence they are considered by the natives as of portentous omen, and as the forerunner of some great calamity. These red-coloured polar lights have of late years been observed in the Shetland Islands; in many parts of Scotland, as in the neighbourhood of Edinburgh; and in England, from its northern to its southern extremity.

Lustre of the Polar Lights.—The lustre varies in kind as well as intensity. Sometimes it is pearly, sometimes imperfectly vitreous, sometimes also metallic. Its degree of intensity varies from a very faint radiance to a light nearly equalling that of the moon.

Progressive Motions.—The reverend James Farquharson states that “the aurora borealis follows a determinate order

Aurora
Borealis.

Aurora
Australis.

Aurora
Borealis.

in its appearance and progress; that the streamers or beams generally appear first in the north, forming an arch from east to west, having its vertex at the line of the magnetic meridian; that when this arch is yet only of low elevation, it is of considerable breadth from north to south, having the streamers of which it is composed placed crossways in relation to its own line, and all directed towards a point a little south of the zenith; that the arch *moves forward towards the south*, contracting its lateral dimensions as it approaches the zenith, and increasing in intensity of light by the shortening of the streamers near the magnetic meridian and the gradual shifting of the angles which the streamers near the east and west extremities of the arch make with its own line, till at length these streamers become parallel to that line, and then the arch is seen as a narrow belt, 3° or 4° only in breadth, extending across the zenith at right angles to the magnetic meridian; that it still makes progress southwards; and, after it has reached several degrees south of the zenith, again enlarges in breadth, by exhibiting an order of appearances the reverse of that which had attended its progress towards the zenith from the north; and that the only conditions which can explain these appearances are, that the streamers of the aurora are vertical, or nearly so, and form a deep fringe or arch, which stretches a great way from east to west at right angles to the magnetic meridian, but which is of no great thickness from north to south; and that the arch moves southward, preserving its direction at right angles to the magnetic meridian." The same gentleman elsewhere remarks, that "the whole lights in the north part of the sky made a rapid progress southward; and the manner of this progress was repeatedly finely exhibited in the fringes and fragments that had reached or passed the zenith, by the extinction of streamers at their northern faces, and the formation of new ones at their southern faces. The advanced southern fringe expired when it had reached about 25° south of the zenith; and all did so, either when they attained a similar angle south, or before they had gone so far. The confused mass of streamers in the north, as they came forward in succession to the zenith, and passed that point, unfolded themselves into narrow zones of light at right angles to the magnetic meridian, or very nearly so; for there was occasionally a small deviation from parallelism among themselves. The zones were more numerous than usual, and were separated from each other by less intervals, sometimes not exceeding 3° or 4° , sometimes, however, 15° or 20° ." (*Edinb. Phil. Mag.*)

Height of the Polar Lights.—Opinions differ as to the elevation of the aurora borealis above the surface of the earth, which is a point that can be determined only by a series of accurate observations. Dr Halley observed that the aurora described by him rose to a prodigious height, it being seen from the west of Ireland to the confines of Russia and Poland on the east, nor did he know how much farther it might have been visible; so that it extended at least 30 degrees in longitude, and from latitude 50° degrees N. it was seen over all the northern part of Europe; and, what was very surprising, in all those places where it was visible, the same general appearances were exhibited which Dr Halley noticed at London. But he observes, with seeming regret, that he could by no means determine its height for want of observations made at different places; otherwise he might easily have calculated the height of the aurora, as he did that of the luminous ball of 1719. Father Boscovich, says he, determined the height of an aurora borealis, observed on the 16th of December 1737 by the Marquis of Poleni, to have been 825 miles; Bergmann, from a mean of thirty computations, makes the average height of the aurora borealis to be 70 Swedish or

upwards of 460 English miles; Euler supposes it to be several thousands of miles in height; and Mairan also assigns it a very elevated region. In the 74th volume of the *Philosophical Transactions* Dr Blagden, speaking of the height of some fiery meteors, remarks that the "aurora borealis appears to occupy as high if not a higher region above the surface of the earth, as may be judged from the very distant countries to which it has been visible at the same time." On the 22d October 1804 it is said that the same polar light was seen at the same time in Saxony and in Liefland. Mr Dalton of Manchester, in a paper read to the Royal Society of London on the 17th April 1828, describes a polar light which he observed on the 29th March 1826, assuming the form of a regular arch at right angles to the magnetic meridian, and continuing for above an hour in the same position; thus affording a favourable opportunity for obtaining the data requisite for determining its height. He took great pains to collect as many authentic accounts as possible of the apparent position of this luminous arch with reference to the stars, when seen from various places where it had been observed in England and in Scotland. And according to Mr Dalton's view of the distribution of the meteor, it appears to have been seen in places 170 miles distant from one another in a north and south direction, and 45 miles distant from east to west, thus comprising an area of 7000 or 8000 square miles; but it must have been visible over a much greater extent. Accounts were received of its having been seen as far north as Edinburgh, and as far south as Manchester and Doncaster, and at most of the intermediate towns. From the exact correspondence of the descriptions at all these places, it was inferred that they referred to the same individual luminous appearance. In proceeding from north to south, the apparent altitude of the arch continually increased, still keeping the south of the zenith to the distance of Kendal, at which place it very nearly crossed the zenith. At Warrington, which is farther south, the culminating point of the arch was north of the zenith; and, wherever seen, the arch always seemed to terminate nearly in the magnetic east and west, at two opposite points of the horizon. The observations in which the author placed the greatest confidence for determining the height of the aurora were those made at Whitehaven and at Warrington, places which are distant 83 miles from each other, and situated nearly on the same magnetic meridian. Calculating from the data they afford, he found the height of the arch very nearly 100 miles above the surface of the earth, and immediately over the towns of Kendal and Kirkby-Stephen. This conclusion is countenanced by observations made at Jedburgh; yet if the former be compared with those at Edinburgh, the height will come out to be 150 or 160 miles, and the position vertical above Carlisle; but he thinks the former result more entitled to confidence. Assuming the height to be 100 miles, it follows that the breadth of the arch would be eight or nine miles; and its visible length, in an easterly and westerly direction from any one place, would be about 550 miles.

But we are disposed to reject these calculations of Dalton, because from the particular details in his memoirs, and the known distribution of the aurora, it is highly probable that the aurora said by him to have been seen at the same time at great distances were different aurora, and then not much elevated above the clouds. Indeed Mr Farquharson, in the *Philosophical Transactions*, part i. 1829, when discussing the value of Mr Dalton's observations, thinks that the observations made from Edinburgh to Warrington might be explained on the supposition that there were several nearly vertical arches of the aurora, almost contemporaneously hanging over many lines from Edin-

Aurora
Borealis.

Aurora
Borealis.

burgh to Warrington, at a few thousand feet above the surface. The observations of Dr Richardson, Captain Franklin, Lieutenant Hood, and others, render it highly probable that many polar lights occur at heights not higher than the region of clouds. Dr Richardson's observations seem to show that the aurora is occasionally seated in a region of the atmosphere, below a kind of cloud which is known to possess no great altitude, namely, that modification of cirro-stratus which, descending low in the atmosphere, produces a hazy sheet of cloud over-head, or a fog-bank in the horizon. Indeed Dr Richardson is inclined to infer that the aurora borealis is constantly accompanied by, or immediately precedes, the formation of one or other of the forms of cirro-stratus. On the 13th of November and 18th December 1826, at Fort Enterprize, its connection with a cloud intermediate between cirrus and cirro-stratus is mentioned; but the most vivid coruscations of the aurora were observed when there were only a few thin attenuated shoots of cirro-stratus floating in the air, or when that cloud was so rare that its existence was only known by the production of a halo round the moon. The natives of the arctic regions of North America pretend to foretell wind by the rapidity of the motions of the aurora; and they say, that when it spreads over the sky in a uniform sheet of light, it is followed by fine weather, and that the changes thus indicated are more or less speedy, according as the appearance of the meteor is early or late in the evening; an opinion not improbable, when it is recollected that certain kinds of cirro-stratus are also regarded by meteorologists as sure indications of rain and wind. Dr Richardson frequently observed the lower surface of nebulous masses illuminated by polar lights; a fact illustrative of the comparatively low situation of these auroræ. Biot, also, in the island of Unst, observed many auroræ that could not be higher than the region of clouds. Captain Franklin in like manner observed low auroræ. "The important fact," says he, "of the existence of the aurora at a less elevation than that of dense clouds was evinced on two or three occasions this night (13th February 1821, at Fort Enterprize), and particularly at 11 hours 50 min., when a brilliant mass of light, variegated with the prismatic colours, passed between an uniform steady dense cloud and the earth, and in its progress completely concealed that portion of the cloud which the stream of light covered, until the coruscation had passed over it, when the cloud appeared as before." Captain Parry, as stated in his third voyage, observed auroræ near to the earth's surface. It is said that while Lieutenants Scherer and Ross and Captain Parry were admiring the extreme beauty of a polar light, they all simultaneously uttered an exclamation of surprise at seeing a bright ray of the aurora shoot suddenly downward from the general mass of light, and between them and the land, which was only three thousand yards distant. The ray or beam of the polar light thus passed within a distance of three thousand yards, or less than two miles, of them. Further, Mr Farquharson observed in Aberdeenshire an aurora borealis not more than four thousand feet above the level of the sea; and he agrees with Richardson, Franklin, &c., in believing that the auroræ occur in a region immediately above that of the clouds, and of course vary in height with the different states of the atmosphere. But although this region was very low on the 20th December 1829, in the polar light seen from Alford, we know that at times it is several miles high, agreeing with the observations of these intelligent travellers. We have frequently seen the aurora when the height of the clouds could not be estimated at less than two or three miles, and at other times not higher than a thousand or fifteen hundred feet.

Position of the Polar Lights.—The arches of the polar lights generally cross the magnetic meridian at right

angles; when two or more appear at once they are concentric, and tend to the magnetic east and west. The beams or streamers in the direction of their length coincide with the plane of the dip of the needle, or nearly so; and each individual streamer is, in fact, parallel to the dipping needle. Dr Richardson thinks he has observed a polarity in the masses of cloud belonging to a certain kind of cirro-stratus approaching to cirrus, by which their long diameters, having all the same direction, were made to cross the magnetic meridian nearly at right angles. But the apparent convergence of such masses of cloud towards the opposite points of the horizon, which have been so frequently noticed by meteorologists, is an optical deception, produced when they are situated in a plane parallel to that on which the observer stands. These circumstances, says Dr Richardson, are here noticed, because, if it shall hereafter be proved that the aurora depends upon the existence of certain clouds, its apparent polarity may perhaps, with more propriety, be ascribed to the clouds themselves which emit the light; or, in other words, the clouds may assume their peculiar arrangement through the operation of one cause (magnetism, for example), while the emission of light may be produced by another, namely, a change in their internal constitution, perhaps connected with a motion of the electrical fluid.

Magnetic Property of the Polar Lights.—Many years ago philosophers remarked that the magnetic needle was agitated during polar lights; and hence it was inferred that these lights were somehow connected with magnetism. Other observers, again, maintained that these observations must be erroneous, as they could not in any instance perceive the compass affected by the presence of this meteor. But the late observations, of Biot, Hansteen, Gay-Lussac, Kupfer, and particularly of Richardson, Franklin, and Farquharson, have demonstrated that the magnetic needle is affected by the polar lights. As the fact is one of the most curious in meteorology, we shall now state some particulars illustrative of its nature. In Captain Franklin's observations, the horizontal compass was placed in a firm sheltered stand, fixed to the back wall of the house at Fort Enterprize, three feet above the ground, on a northern exposure; and the dipping needle was similarly fixed to the end of the storehouse, at the distance of forty feet. There was no iron near either of them. The house stood on a sand-hill, and there were no large stones in its immediate neighbourhood. The horizontal compass belonged to a small variation transit made by Dollond; and its graduated scale, of one and a half inch radius, was divided into degrees, the degrees counting from north towards west to 360. Each degree was subdivided into 20, and, by the assistance of a magnifying glass, he could read it off accurately to within three minutes. The horizontal position was preserved by means of a spirit-level attached to the instrument.

The manner in which the needle is affected by the aurora will require some description. "The motion communicated to it," says Captain Franklin, "was neither sudden nor vibratory. Sometimes it was simultaneous with the formation of arches, prolongation of beams, or certain other changes of form or action of the aurora. But generally the effect of these phenomena upon the needle was not visible immediately, but in about half an hour or an hour the needle had attained its maximum of deviation. From this its return to its former position was very gradual, seldom regaining it before the following morning, and frequently not until the afternoon, unless it was expedited by another arch of the aurora operating in a direction different from the former one.

"The arches of the aurora," he adds, "most commonly traverse the sky nearly at right angles to the magnetic

Aurora
Borealis.

Action of
the polar
lights on
the compass.

Aurora
Borealis.

meridian, but the deviations from this direction, as has been already stated, were not rare; and I am inclined to consider that these different positions of the aurora have considerable influence upon the direction of the needle. When an arch was nearly at right angles to the magnetic meridian, the motion of the needle was towards the west; this westward motion was still greater when one extremity of an arch bore 301° , or about 59° to the west of the magnetic north, that is, when the extremity of the arch approached from the west towards the magnetic north. A westerly motion also took place when the extremity of an arch was in the true north, or about 36° to the west of the magnetic north, but not in so great a degree as when its bearing was about 301° . A contrary effect was produced when the same end of an arch originated to the southward of the magnetic west, viz. when it bore from about 245° to 234° , and, of course, when its opposite extremity approached nearer to the magnetic north. In these cases the motion of the needle was towards the east. In one instance only a complete arch was formed in the magnetic meridian; in another, the beam shot up from the magnetic north to the zenith; and in both these cases the needle moved towards the west.

"The needle was most disturbed on February 13, P. M., at a time when the aurora was most distinctly seen passing between a stratum of clouds and the earth, or at least illuminating the face of the clouds opposed to the observer. This and several other appearances induced me to infer that the distance of the aurora from the earth varied on different nights, and produced a proportionate effect on the needle. When the light shone through a dense hazy atmosphere, when there was a halo round the moon, or when a small snow was falling, the disturbance was generally considerable; and on certain hazy cloudy nights the needle frequently deviated in a considerable degree, although the aurora was not visible at the time. Our observations do not enable us to decide whether this ought to be attributed to an aurora concealed by a cloud or haze, or entirely to the state of the atmosphere. Similar deviations have been observed in the day-time, both in a clear and cloudy state of the sky, but more frequently in the latter case. Upon one occasion the aurora was seen immediately after sunset, whilst bright day-light was remaining. A circumstance to which I attach some importance must not be omitted. Clouds have been sometimes observed during the day to assume the forms of the aurora, and I am inclined to connect with the appearance of these clouds the deviation of the needle, which was occasionally remarked at such times. An aurora sometimes approached the zenith without producing any change in the position of the needle, as was more generally the case; whilst at other times a considerable alteration took place although the beams or arches did not come near the zenith. The aurora was frequently seen without producing any perceptible effect on the needle. At such times its appearance was that of an arch, or an horizontal stream of dense yellowish light, with little or no internal motion. The disturbance in the needle was not always proportionate to the agitation of the aurora; but it was always greater when the quick motion and vivid light were observed to take place in a hazy atmosphere. In a few instances, the motion of the needle was observed to commence at the instant a beam darted upwards from the horizon; and its former position was more quickly or slowly regained according to circumstances. If an arch was formed immediately afterwards, having its extremities placed on opposite sides of the magnetic north and south to the former one, the return of the needle was more speedy, and it generally went beyond the point from whence it first started."

A series of interesting observations on this subject were

also made in December 1829, by the reverend James Farquharson, F. R. S., of Aberdeenshire, with an apparatus transmitted to him by the Royal Society of London. This apparatus consisted of a horizontal brass circle, about one foot in diameter, graduated to divisions of ten minutes, and capable of adjustment to a perfect level by means of spirit levels and screwed feet. Concentrically within this divided circle moved a circular horizontal brass plate, its edge touching the divisions, and having at opposite points two verniers, which, by means of attached microscopes, indicated the movements which it made to 60th parts of ten minutes, or $10''$. The movement of the plate within the circle was effected by means of a screw. A circular brass needle-box was attached to the surface of the inner plate, and a vertical pointed steel wire for supporting the needle formed the centre. At opposite points in the needle-box were fixed two micrometers, with cross wires in the foci, for adjusting the needle to a level, and observing any change in its direction. The top of the needle-box was a circular plate of ground glass in a brass ring, made to slip easily off and on, and having screwed into its centre a vertical brass tube about eight inches long, for the purpose of suspending the needle with fibres of silk, for measuring the time of its oscillations. A horizontal brass pin, with a minute perforation for the silk near its middle, passed through the vertical tube near its top, and being contrived with several motions, served to adjust the suspended needle, and bring it correctly over the steel point, where its levelling could be completely ascertained. The magnetic needle itself was a rectangular plate about five inches long, half an inch broad, and $\frac{1}{40}$ th of an inch thick. An agate cup set in brass admitted of being screwed in either at the narrow or flat side of the needle; and a little fixed ring of brass, with a minute perforation in its top, rising over the cup, admitted of the ready attachment of the silk; so that the needle could be placed on the steel point, or suspended with the silk, with its flat face either vertical or horizontal. This apparatus measured, with great accuracy, very minute changes in the declination of the needle, one so small as $10''$ being quite sensible by it.

The observations made with this apparatus, and published in the *Transactions of the Royal Society of London* for 1830, also show, in a most satisfactory manner, that the magnetic needle is actually affected by the presence of the polar lights. They equally prove that the needle is not in every instance agitated by the polar lights, even when they are very brilliant; the oscillations taking place only when the beams or fringes of the meteor are in the same plane with the dip of the needle. But as the needle is affected in those planes only where the fringes or arches are in the plane just mentioned, it is evident that observers in different latitudes may obtain very discordant results in the same evening. The observations collected by Dalton, of the appearance of the aurora of the 29th March 1826, prove that many fringes or arches may be parallel to each other at remote distances; and the observations of the President of the Royal Society, on a luminous arch in Cornwall, 29th September 1828, which appeared simultaneously with a remarkable aurora of many arches extending over the whole of Aberdeenshire, show that the meteor is sometimes active over a space nearly coincident with the extent of the kingdom; and there is reason for believing that it often extends much farther. There might, therefore, be an extensive succession of observations of disturbance and non-disturbance of the needle at the same instant from north to south over many degrees of latitude.

Noises from the Aurora Borealis.—Having, many years ago, both in this country and in the Shetland Islands, heard very distinctly noises proceeding from the polar lights, we

Aurora
Borealis.

Aurora
Borealis.

Aurora
Borealis.

have always given full credit to the statements of those observers who have published accounts of this fact. It is true that late observers, as Scoresby,¹ Richardson,² Franklin, Parry, and Hood, never heard such noises, although they do not deny that they may have been heard. Thus Richardson says, "I have never heard any sound that could be unequivocally considered as originating in the aurora; but the uniform testimony of the natives, both Crees and Copper Indians, and Esquimaux, and of all the older residents in the country, induces me to believe that its motions are sometimes audible." Captain Franklin says, "I have not heard the noise ascribed to the aurora, but the uniform testimony of the natives and of the residents in this country induces me to believe that it is occasionally audible." Parry frequently listened for sounds from the polar lights, but never heard any. Lieutenant Hood says (Franklin's *Narrative*, p. 535), "We repeatedly heard a hissing noise, like that of a musket bullet passing through the air, which seemed to proceed from the aurora; but Mr Wentzel assured us that this noise was occasioned by severe cold succeeding mild weather, and acting upon the surface of the snow previously melted in the sun's rays. The temperature of the air was then — 35°, and on the two preceding days it had been above zero. The next morning it was — 42°, and we frequently heard a similar noise. Mr Hearn's description of the noise of the aurora agrees exactly with Mr Wentzel's, and with that of every other person who heard it. It would be an absurd scepticism to doubt the fact any longer, for our observations have rather increased than diminished the probability of it." Muschenbroeck says that the Greenland fishers in his time assured him that they had frequently heard noises proceeding from the aurora borealis. Mr Nairne is confident that he has heard a hissing and whizzing noise when the polar lights were very bright; and Mr Cavallo affirms that he more than once heard a crackling noise from polar lights. Giesecké, who resided so long in West or Old Greenland, says, "the polar lights sometimes appear very low, and then they are much agitated, and a crashing and crackling sound is heard, like that of an electric spark, or the falling of hail." Professor Parrot of Dorpat describes a magnificent polar light he witnessed on the 22d October 1804, from which a crackling and rustling noise proceeded. "We learn from the inhabitants," says Captain Brooke, in his interesting travels through Norway, "with respect to the polar or northern lights, that they had frequently heard the noise that sometimes attends them, which they describe like that of a rushing wind. At Hammerfest they said they were violent, and descended so low that it would appear almost possible to touch them." In a letter from Mr Ramm of Tonset in Norway, addressed to Professor Hansteen, and published in the *Magazin für Naturwissenschaftler*, Christiana, 1825, we are told that he several times heard a quick whispering noise simultaneously with the motion of the beams of the polar lights. In the same journal, Professor Hansteen says, "The polar regions being in reality the native country of the polar light, we ought to be particularly interested in obtaining any additional information on the natural history of this remarkable phenomenon; and we have so many certain accounts of the noise attending it, that the negative experience of southern nations cannot be brought in opposition to our positive knowledge. Unfortunately, we live, since the beginning of this century, in one of the great pauses of this phenomenon; so that the present generation knows but little of it from personal observation. It would

therefore be very agreeable to receive, from older people, observations of this kind, made in their youth, when the aurora borealis showed itself in full splendour. It can be proved mathematically that the rays of the northern lights ascend from the surface of the earth, in a direction inclining towards the south (an inclination which, with us, forms an angle of about 73°). If, then, this light occupies the whole northern sky, rising more than 17° above the zenith, the rays must proceed from under the feet of the observer, although they do not receive their reflecting power till they have reached a considerable elevation, perhaps beyond our atmosphere. It is therefore conceivable why we should frequently hear a noise attending the northern lights, when the inhabitants of southern countries, who see the phenomenon at a distance of many hundred miles, hear no report whatever. Wargentin, in the fifteenth volume of the *Transactions of the Swedish Academy*, says, that Dr Gisler and Mr Hellant, who had resided for some time in the north of Sweden, made, at the request of the academy, a report of their observations on the aurora borealis." To these observations Professor Hansteen adds, that Captain Abrahamson, in the *Transactions of the Scandinavian Literary Society*, has given an account of several observations of noises that were heard proceeding from the northern lights. The professor concludes with stating that he himself knows several persons who have distinctly heard the same sounds; he expresses his surprise that a fact so well established should be called in question; and he relates, with some sharpness, a conversation he once had on this subject with an Englishman, who remarked that the Norwegian tales of noises proceeding from polar lights were akin to the ghost stories of this country.

Theory of the Aurora Borealis.—The theory of this phenomenon is involved in the copious details which have been given under the different foregoing heads; and, indeed, from all that is known, it appears reasonable to infer that it is intimately connected with electricity and magnetism. "The aurora borealis," says Dr Young, "is certainly in some measure a magnetical phenomenon; and if iron were the only substance capable of exhibiting magnetic effects, it would follow that some ferruginous particles must exist in the upper regions of the atmosphere. The light usually attending this magnetical meteor may possibly be derived from electricity, which may be the immediate cause of a change in the distribution of the magnetic fluid contained in the ferruginous vapours which are imagined to float in the air." (*Lectures*, vol. i. p. 687.) This assumption of ferruginous particles or vapours, however, seems purely gratuitous and imaginary; and as iron is not the only substance or matter capable of exhibiting magnetic effects, light itself being susceptible of polarization, the above hypothesis is therefore untenable even on the ground on which it has been rested by its author. But it is nevertheless certain that the cause of this luminous meteor is intimately connected with magnetism and electricity; or rather, as the magnetic is variously modified and affected by the electric power, with the phenomena of electro-magnetism. "It is doubtful," says Dr Young in another place, "whether the light of the aurora borealis may not be of an electric nature; the phenomenon is certainly connected with the general cause of magnetism;" and he refers in support of this opinion to the ascertained fact that the primitive beams or rays of light are constantly observed in a direction parallel to that of the dipping needle; adding, that "although the substance be magnetical, the illumination which renders it visible may still be derived from the passage of electricity,

¹ *Arctic Regions, and Journal of a Voyage to the Northern Whale Fishery.*

² *Remarks on the Aurora Borealis, in Franklin and Richardson's Journey to the Shores of the Polar Sea.*

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at too great a distance to be discovered by any other test." (*Lectures*, vol. i. p. 716.) The fact is, that in magnetism, the agency of electricity is now clearly made out, and they are shown to stand to each other in the relation of effect and cause, at least in as far as that all the phenomena of magnetism are producible by electricity; but no electric phenomena have ever been hitherto produced by magnetism. (Herschel's *Preliminary Discourse*, p. 93.) Hence the aurora "is certainly connected with the general cause of magnetism," in as far as it is a joint result or effect of the cause by which it is now known that all the phenomena of magnetism are producible; but this connection is one of relation or coincidence merely; and hence it is to the agency of electricity that the phenomena of the aurora are primarily to be ascribed. "This wonderful agent," says Mr Herschel, "which we see in intense activity in lightning, and in a feebler and more diffused form traversing the upper regions of the atmosphere in the northern lights, is present, probably in immense abundance, in every form of matter which surrounds us, but becomes sensible only when disturbed by excitements of peculiar kinds." (*Prelim. Discourse*, p. 329, 330.) Mr Canton, likewise, conceives that the aurora is occasioned by the rapid transition or passage of electrical matter from positive towards negative clouds, throughout the upper region of the atmosphere, where the resistance is the least; but he supposes that the aurora which appears at the time when the magnetic needle is disturbed is not the cause of this disturbance, which he attributes to the heat of the earth, and that it is merely the electricity of the heated air above, disengaged chiefly in the northern regions, where the alteration in the temperature of the air is greatest. Be this as it may, however, the experiment contrived by Mr Canton shows clearly that the phenomena of the aurora are intimately connected with, or rather consequent on, a particular constitution of the atmosphere in regard to density and electricity. If, for example, a glass tube about three feet in length be partially exhausted of air, hermetically sealed, and then applied longitudinally to the prime conductor of an electrical machine, the whole tube will be illuminated from end to end, and this illumination will continue for a considerable time after it has been removed from the conductor. If, again, the tube be drawn through the hand either way, the light will become remarkably intense throughout its whole length; and although a great part of the electricity will be discharged by this operation, the tube will nevertheless emit flashes at intervals, if held by one extremity and kept quite steady; while, if grasped by the other hand at a different place, vivid flashes of light will dart from one end to the other, and continue to be emitted for a considerable time without any fresh excitation. It is to be observed, however, that if the density of the air included in the tube be either increased or diminished beyond a certain limit, none of these luminous appearances will be exhibited; and it is this circumstance which shows that the phenomena of the aurora depend on a certain constitution of the atmosphere in point of density and electricity, and that the meteoric appearances or coruscations can never attain the elevation ascribed to them by some philosophers, but must in every case be confined within the limits of our atmosphere, conformably to the observations of Biot and others already detailed. Beccaria, indeed, conjectures that there is a constant and regular circulation of the electric fluid from north to south; and he gives it as his opinion that the aurora borealis is this electric matter performing its transit southwards, in a state of the atmosphere which renders it visible, or approaching nearer than usual to the earth. But such a transition or circulation as that here suggested could only be produced by the diurnal revolution of the earth round its axis; and as the meteor is observed in the

southern with nearly the same appearances as in the northern hemisphere, there must consequently be a circulation from south to north as well as from north to south; in other words, if there be any such tendency as that which Beccaria supposes, it must proceed equally or nearly so from both poles towards the equator. The following is a list of the most important papers, treatises, and works on this subject: *Berlin Mem.* 1710, i. 131; Halley, *Phil. Trans.* 1716, 1719, xxix. 406, xxx. 584; Hearne, *Phil. Trans.* xxx. 1107; Langworth, Huxham, Hallet, and Calendrini, *Phil. Trans.* xxxiv. 132, 150; Maier, *C. Petr.* iv. 121; Mairan, *Traité de l'Aurore Boréale*, 1733, 1754; Weidler, *de Aurora Boreali*, 4; Wargentin, *Phil. Trans.* 1751, p. 126, and *History*, 1752, p. 169, 1753, p. 85; Bergmann, *Schw. Abh.* 200, 251; Wiedeburg, *über die Nordlichter*, 8, Jena, 1771; Hüpsch, *Untersuchung des Nordlichts*, 8, Cologne, 1778; Van Swinden, *Recueil de Mémoires*, Hague, 1784; Cavallo, *Phil. Trans.* 1781, p. 329; *E. M. Physique*, art. Aurore Boréale; Wilke *von den Neuesten Erklärungen des Nordlichts*, Schwedisches Mus. 8, Wismar, 1783; Hey, Wollaston, Hutchinson, Franklin, Pigott, and Cavendish, *Phil. Trans.* 1790, pp. 32, 47, 101; Dalton's *Meteorological Observations*, 1793, p. 54, 153; Chiminello *on a Luminous Arch*, Soc. Ital. vii. 153; Ritter *on the Lunar Periods of the Aurora*, Gilb xv. 206.

AURUNGABAD, a large province of Hindostan, in the Deccan, about 300 miles in length by 160 in average breadth. It is situated principally between the 18th and 19th degrees of north latitude, and is bounded on the north by Gujerat, Khandeish, and Berar; on the east by Beeder; on the south by Bejapoor, from which it is separated by the Neera and Beema rivers; and on the west by the Indian Ocean. The great chain of the Ghauts runs through this province in a direction north and south, at the distance of about 100 miles from the Indian Ocean, and rises to a very considerable elevation; and the surface of the country, particularly in their neighbourhood, is irregular, and in general mountainous. The rivers which rise on the western declivity of these mountains, and flow into the Indian Ocean, have necessarily a short course, and are inconsiderable in size; while those again which have their sources on the eastern declivity of the mountains, and flow eastward into the Bay of Bengal, such as the Beema, the Neera, and the Godavery, do not attain any considerable size until they are beyond the limits of this province. Rice is the great staple of agriculture, especially in the lower districts, which are in general fertile, and, besides supplying the wants of the inhabitants, yield a surplus for exportation. A different mode of agriculture is however followed in the higher districts. The other vegetable productions, besides rice, are the same as in other parts of Hindostan. Horses of a hardy breed are reared in great numbers for the Mahratta cavalry; but they are neither strong nor handsome, though they suit the light weight of the riders for whom they are intended. A great proportion of this province, and almost all the sea-coast, were long in possession of the Mahrattas, who were pirates by sea as well as robbers by land: they seldom ventured on the ocean except as pirates, and they continued their predatory habits by sea and by land until they were restrained by the strong arm of British power. Three-fourths of the province were formerly subject to the Peishwa, and the remainder to the Nizam; with the exception of the islands of Bombay, Salsette, and a few tracts on the main land. The inhabitants are not supposed to exceed six millions, of whom not above one-twentieth are of the Mahometan persuasion. The language commonly used is the Mahratta, but there are besides various provincial dialects.

AURUNGABAD, the capital of the above province, which

Aurunga-
bad.

Auschwitz was formerly named Gurka. It was the capital of the Mogul conquests; and having become the favourite residence of Aurungzebe during his viceroyalty of the Decan, it received the name of Aurungabad, from which the name of the province was derived. The city contained the capital of the modern Nizams after they became independent of Delhi, until they quitted it for Hyderabad. The city has fallen from its ancient grandeur. The interior is but half peopled and in ruins, and presents all the appearances of desertion and decay. The population is, however, still considerable; and in the bazaar, which is very extensive, are exposed for sale various kinds of commodities, European and Indian, particularly silks and shawls. The walls are similar in their construction to those of all the other cities in this quarter in India, being rather low, with round towers. The travelling distance from Poona is 186 miles, from Bombay by Poona 284, from Hyderabad 295, from Madras 647, from Delhi 750, and from Calcutta 1022 miles. Long. 75. 33. E. Lat. 19. 54. N.

Australasia.

Auspex
Australasia.

AUSCHWITZ, a city at the confluence of the Sola and the Vistula, formerly a ducal seat, in the circle of Myslenicze, in the Austrian province of Galicia.

AUSI, an ancient and very savage people of Libya. Herodotus tells us that they were unacquainted with marriage, and had all their women in common. The children were brought up by their mothers till they were able to walk; after which they were introduced to an assembly of the men, who met every three months, and the man to whom any child first spoke acknowledged himself its father. They celebrated annually a feast in honour of Minerva, in which the girls, dividing into two companies, fought with sticks and stones, and those who died of their wounds were concluded not to have been virgins.

AUSONIA, the ancient name of Italy, so called from its earliest inhabitants the Ausones.

AUSONIUM MARE, in *Ancient Geography*, a part of the Ionian Sea, extending southward from the promontory Japygium to Sicily, which it washes on the east, as it does the Bruttii and Magna Græcia on the south and east. It is separated from the Tuscan Sea by the Strait of Messina.

AUSONIUS (*Decimus Magnus*), one of the best poets of the fourth century, was the son of an eminent physician, and born at Bourdeaux. Great care was taken of his education, the whole family interesting themselves in it, either because his genius was very promising, or that the scheme of his nativity, which had been cast by his maternal grandfather, led them to imagine that he would one day rise to great honour. He made uncommon progress in classical learning, and at the age of thirty was chosen to teach grammar at Bourdeaux. He was promoted some time after to be professor of rhetoric; in which office he acquired so great a reputation that he

was sent for to court to be preceptor to Gratian, the emperor Valentinian's son. The rewards and honours conferred on him for the faithful discharge of his office prove the truth of Juvenal's maxim, that when fortune pleases she can raise a man from the humble rank of rhetorician to the dignity of consul. He was actually appointed consul by the emperor Gratian in the year 379, after having filled other considerable posts; for besides the dignity of questor, to which he had been nominated by Valentinian, he was made prefect of the prætorium in Italy and Gaul after that prince's death. His speech, returning thanks to Gratian on his promotion to the consulship, is highly commended. The time of his death is uncertain; but he was alive in 392, and is said to have attained a great age. The emperor Theodosius had a great esteem for Ausonius, and pressed him to publish his poems. There is great inequality in his works; and in his manner and style there is a harshness which was perhaps rather the defect of the times in which he lived than of his genius. The best editions of his poems are that of Amsterdam in 1671, in 8vo, and that of Paris in 1728, in 4to.

AUSPEX, a name originally given to those who were afterwards denominated *augurs*. The word is evidently formed from *avis*, bird, and *inspicere*, to inspect; *auspices*, q. d. *avis pices*.

AUSSERHODEN, one of the districts of the canton of Appenzell, in Switzerland, comprehending two thirds of that territory, being 227 square miles, or 145,280 acres, and containing 42,000 inhabitants. It is subdivided into two parts, namely, the Hither and Farther Gitten. All the inhabitants of this latter district adhere to the Protestant reformed church, as those of the former do to the Romish faith, which renders the administration of the two parts distinct from each other.

AUSTER, one of the four cardinal winds, as Servius calls them, blowing from the south.

AUSTERLITZ, a small town of Moravia, situated twelve miles south-east of Brunn. It contains hardly 2000 inhabitants, but has been rendered memorable by the great victory obtained in its vicinity, on the 2d December 1805, by the French under Napoleon, over the united forces of Austria and Russia under their respective emperors.

AUSTLE, ST, a market-town of the hundred of Powden, in the county of Cornwall. It stands in the centre of the county, and is surrounded by a district rich in mines, and abounding in clay used in the potteries of Staffordshire. There are also some manufactures of woollen cloths. The market is held on Friday, and is well supplied. It is 243 miles from London, and 13 from Truro. The population in 1801 amounted to 3788, in 1811 to 3686, and in 1821 to 6175. The increase of inhabitants between 1811 and 1821 has therefore been great.

AUSTRALASIA,

Introduc-
tory obser-
vations. In modern geography, the *fifth* great division of the earth's surface. A systematic classification in geography is as necessary to enable us to form clear and comprehensive views of its objects, as it is in botany, mineralogy, geology, or any other department of physical science, though incapable of being brought to the same degree of perfection. The rapid progress made, during the last fifty years of the past century, in the discovery of those almost innumerable islands that are scattered over the three great oceans, the Indian, the Southern, and the Pacific, peopled by various races of human beings, differing in their features, manners, dispositions, and language, forcibly demanded some such systematic arrangement, otherwise, as the

President de Brosses has observed, "the sight would be dazzled and confounded, if care were not exerted to relieve it, and fix its attention by divisions marked from distance to distance."

It was this learned and very intelligent writer who first suggested that all the lands and islands in the Austral world should be divided into three portions, corresponding with the three great oceans, the Indian or Ethiopic, the Atlantic, and the Pacific; those in the Indian Ocean and to the south of Asia to be named *Australasia*; those in the two Pacifics, from the multitude of islands, *Polynesia* (a name first used, we believe, by De Barros); and those in the Atlantic to the south of Cape Horn and the Cape

Australasia. of Good Hope, *Magellanica*. The last, however, became unnecessary, as soon as it was ascertained that the *Terra Australis incognita* had no existence. Some idea may be formed of the rapid progress made in maritime geography, even within the last fifty years, and of its imperfection previous to that period, when it is stated, that, in the year 1770, an enlightened and industrious hydrographer, the late Alexander Dalrymple, asserted that the *great southern continent* was not then a matter of *discovery*, for that it had been seen on the west by Tasman in 1642, and on the east by Juan Fernandez above half a century before; adding, without any doubt or hesitation, that "the countries intermediate, equal in extent to all the civilized part of Asia, from Turkey to China inclusive, still remain unexplored." Nay, more, "that it extended from 30° south to the pole, and that the number of its inhabitants was probably more than fifty millions." All these facts he discovers in the Spanish and Portuguese voyages in the South Pacific Ocean. (*Historical Collections*.)

The two divisions of Australasia and Polynesia will be found to comprehend, with sufficient convenience, all those islands that cannot with propriety be referred to any of the four continents of the globe. Nor is there any difficulty in drawing a line of separation between these two divisions; though it is not quite so easy to mark the distinct boundary between the Australasian and the Asiatic islands, where they melt into each other, about the equator, at the north-west extremity of Papua or New Guinea. In a geographical view, the small islands of Waygiou, Salwatty, Batanta, Mysol, and Timorlaut, ought strictly to belong to Australasia; but, peopled as they are by Asiatics of the Malay tribe, and under the influence of the Dutch settlements, it may perhaps be more proper, in a moral and political point of view, to consider them as belonging to the Asiatic islands; more particularly as we shall then have all the Australasian population, with very few exceptions, marked with more or less of the African or Negro character. But, in fact, all geographical divisions are and must be to a certain degree arbitrary.

Boundaries. If, then, we take the equator as the northern boundary from the 132° to the 175° of east longitude; continue a line on the latter meridian to the 55th parallel (bending a little to take in New Zealand) for the eastern; another line along the same parallel to the 65th degree of east longitude for the southern; and a slanting line to the point on the equator from which we set out, so as to include Kerguelen's Land, and pass on the eastern sides of Timorlaut, Ceram, Mysol, and Salwatty, for the western boundary; those lines will circumscribe the whole of the Australasian islands. We have included the uninhabited islands of Kerguelen and St Paul and Amsterdam, because they cannot properly be considered as African islands, though arranged, we believe, under that division by Pinkerton: they are of less importance to geography than to geology.

Australasia, then, may be subdivided into the following groups and islands:—

1. Notasia, or New Holland.
2. Van Diemen's Land.
3. Papua, or New Guinea.
4. New Britain, New Ireland, and neighbouring islands.
5. Solomon's Islands.
6. New Hebrides.
7. New Caledonia.
8. New Zealand, and Isles to the southward.
9. Kerguelen's Islands, or Islands of Desolation.
10. St Paul and Amsterdam.
11. Numerous reefs and islets of coral scattered over the Australasian Sea.

New Holland.

- I. The first attempt to explore this island, which, from

its size, may be considered as the fifth continent of the **Australasia.** earth, is unquestionably due to the Dutch; for although some part of the northern coast may have been seen by the early navigators of Spain and Portugal, there is no direct testimony in favour of such a discovery. There are two charts in the British Museum which belonged to the *Harleian Collection*; one French, without date, which was probably the original; and the other English, apparently a copy: the latter is dedicated to the king of England, and bears date 1542. In both of these charts is marked down an extensive tract of country to the southward of the Moluccas, under the name of *Great Java*, agreeing more nearly with the position and extent of New Holland than any other land. The form given to the north-west part of the coast in these charts approaches nearest to the truth; a part, indeed, which may have been seen by those early navigators who visited the Moluccas long before the date of the English chart. It is a singular coincidence in geographical nomenclature, that, on the east coast of the French chart, something like a *Botany Bay* should be designated under the name of *Coste des Herbaiges*. The Abbé Prévost, in the *Histoire Générale des Voyages*, and the President de Brosses, in his *Histoire des Navigations aux Terres Australes*, are not very happy in advancing a claim in favour of Paulovier de Gonville, a French captain, to the discovery of this *Terra Australis* in 1504. It was the coast of Madagascar upon which Gonville was driven, as is evident by their own accounts.

Progress of discovery.

The best and most authentic abstract of the Dutch discoveries on the coasts of New Holland is contained in the instructions given by the governor-general of Batavia to Commodore Abel Janzen Tasman, and published by Mr Dalrymple in his *Collection concerning Papua*. From this document it appears that the Dutch government of Bantam in 1605 dispatched the Duyfhen yacht to explore the islands of New Guinea. Returning to the southward along the islands on the northern side of Torres Strait, she came to that part of the *Great South Land* which is now called Cape York; but all these lands were then thought to be connected, and to form the southern coast of New Guinea. "Thus," says Captain Flinders, "without being conscious of it, the commander of the Duyfhen made the first authenticated discovery of any part of the *Great South Land*, about the month of March 1606." About the same place, and in the same year, Torres, a Spanish navigator, being second in command to Fernandez de Quiros, saw the *Terra Australis*, but had as little knowledge of the nature of his discovery as the commander of the Duyfhen. He passed the strait, however, which divides this *Terra Australis* from New Guinea, whose existence was not generally known till 1770, when it was re-discovered and passed by our great circumnavigator Captain Cook. Of this, and his other discoveries, Torres addressed an account to the king of Spain, and, as it afterwards appeared, had taken the precaution to lodge a copy of it in the archives of Manilla; for, when that city was surrendered to the British forces in 1762, Mr Dalrymple snatched from oblivion this interesting document of early discovery, and, as a just tribute to the enterprising Spanish navigator, he gave to this passage the name of *Torres Strait*, by which it is now universally known.

In 1617 the Dutch sent a second expedition, but "with little success;" the journals of which were lost. In 1623, the yachts Pera and Arnheim were dispatched from Amboyna, under the command of Jan Carstens, who, with eight of the Arnheim's crew, was treacherously murdered by the natives of New Guinea; but the vessels prosecuted the voyage, and discovered the great islands Arnheim and the Spult. The Arnheim returned to Amboyna; the Pera persisted, and ran along the west coast of New

Australasia. Guinea, as they thought, but in reality New Holland, to Cape Keer-veer or Turn-again, and from thence explored the coast farther southward, as far as 17°, to Staten River. "In this discovery were found everywhere shallow water and barren coasts, islands altogether thinly peopled by divers cruel, poor, and brutal nations; and of very little use to the (Dutch East India) Company."

The next expedition sent by the Dutch was from Banda in the year 1636, when Gerrit Tomaz Pool proceeded with the yachts Klein Amsterdam and Wesel, and nearly at the same place, on the coast of New Guinea, met the same fate which had befallen Carstens; but the supercargo, Pieterse, continued the voyage, and discovered the coast of Arnheim, or Van Diemen's Land, in 11° S., and sailed along the shore 120 miles, but without seeing any inhabitants.

Abel Jansen Tasman sailed on a second voyage of discovery from Batavia in 1644; but no account of this voyage was ever made public, nor is it known to exist. No chart bearing his name is now known, but there is little doubt that the north-west coast of New Holland was first explored by him; and it is singular enough that Dampier should say he had Tasman's chart of it. Tasman is also supposed to have sailed round the Gulf of Carpentaria; an opinion which Captain Flinders considers to be strengthened, from the names of Tasman, of the governor-general, and of two of the council, who signed his instructions, being applied to places at the head of the gulf, as well as that of Maria, the governor's daughter, to whom Tasman is said to have been attached. Tasman had sailed, on a former voyage, from Batavia in 1642, for the Mauritius; whence steering south and eastward upon discovery, he fell in with land, to which he gave the name of *Anthony Van Diemen's Land*, in honour of the governor-general, "our master," he adds, "who sent us out to make discoveries."

The last voyage undertaken by the Dutch for the discovery of *Terra Australis* was in 1705, when three Dutch vessels were sent from Timor, "with orders to explore the north coast of New Holland better than it had been done before." The account, however, given by the President de Brosses is so vague and imperfect that very little satisfactory information is to be obtained from it. It is on the west coast that the Dutch appear to have been most successful. In Tasman's instructions it is stated, that "in the years 1616, 1618, 1619, and 1622, the west coast of this great *unknown* southland, from 35° to 22° south latitude, was discovered by outward-bound ships, and among them, by the ship *Endragt*." Dirk Hartog commanded this ship, and seems to have made the coast in latitude about 26° 30' S., and to have sailed northward along it to about 23°, giving the name of *Landt van Endragt* to the coast so discovered; and that of Dirk Hartog's Road (called afterwards *Shark's Bay* by Dampier) to an inlet on the coast a little to the southward of 25°. A plate of tin was found in 1697, and again seen by Baudin in 1801, on one of the islands which forms the roadstead, bearing an inscription that the ship *Endragt* of Amsterdam arrived there on the 25th October 1616. After this several outward-bound ships fell in by accident with different parts of this coast.

The Dutch made little progress in any other part of the extensive coasts of New Holland. The instructions to Tasman say, "In the year 1627 the south coast of the Great South Land was accidentally discovered by the ship the *Guldee Zeepard*, outward bound from Fatherland for the space of 1000 miles." From the circumstance of this ship having on board Pieter Nuyts, who was sent from Batavia as ambassador to Japan, and afterwards appointed governor of Formosa, the name of *Nuyts' Land* was given to this long range of coast.

The first English navigator who appears to have seen any part of New Holland is the celebrated William Dampier, who, in his buccaneering voyage round the world, in January 1686, touched at the north-west coast, for the purposes of careening his vessel and procuring refreshments. He made the land in latitude 16° 15', and ran along the shore to the north-east till he came to a bay or opening fit for the purpose. In 1699 Dampier a second time visited the north-western coast of this *Terra Australis*, being now legitimately employed in making discovery in his Majesty's ship the *Roebuck*. Of this part of the coast little more is yet known than what has been described by Dampier, and that little is due to the exploration of Captain King.

It was left for our celebrated navigator Captain Cook to complete the grand outline of the fifth continent of the world. The reign of George III. will ever be distinguished for the liberal principles on which voyages of discovery were undertaken, and their results communicated to the world. The *Endeavour* was fitted out to observe, at Tahiti, the transit of Venus over the sun's disk; on her return, in 1770, Captain, then Lieutenant Cook, explored the whole east coast of the *Terra Australis Incognita*, from Cape Howe to Cape York, not minutely entering into the details of every part, which would have been impossible, but laying down a correct general outline. "He reaped," says Captain Flinders, "the harvest of discovery; but the gleanings of the field remained to be gathered." In his passage through Endeavour Strait, between Cape York and the Prince of Wales' Islands, he not only cleared up the doubt which till then existed, of the actual separation of *Terra Australis* from *New Guinea*, but, by his accurate observations, enabled geographers to assign something like a true place to the former discoveries of the Dutch in these parts.

In 1777 Captain Cook, in the *Resolution* and *Discovery*, visited Van Diemen's Land; but as Captain Furneaux, in his Majesty's ship *Adventure*, had preceded him four years, and Tasman and Marion had examined the coast, little was here supposed to remain for discovery, except in detail. It was long subsequent to Furneaux's visit that Van Diemen's Land was ascertained to be an island; a discovery which may have been retarded by that officer having given an opinion "that there is no strait between New Holland and Van Diemen's Land, but a very deep bay." The existence of such a strait was however suspected; but the various attempts to ascertain it, without success, by different navigators from both sides of the coast, seemed to have decided the question in the negative, when Mr Bass, surgeon of the *Reliance*, having observed, as he ran down the east coast in an open whale boat, that a heavy swell rolled in from the westward, was satisfied in his own mind that such a swell could proceed only from the great Southern Ocean. To ascertain whether this was the fact, was a point of great importance to the new colony on the eastern coast; and for this purpose Mr Flinders, together with Mr Bass, was sent on this service in a small decked boat. At the end of three months they returned to Port Jackson, with an interesting account of the survey of the coasts of Van Diemen's Land, which they had completely circumnavigated, and thus confirmed the conjecture of Mr Bass, whose name the strait deservedly bears.

The French are entitled to the honour of some partial discoveries on *Terra Australis*. Captain Marion was dispatched in the year 1772 from the Isle of France with two ships, the *Mascarin* and *Marquis de Castries*, on a voyage of discovery, one of the objects of which was that of the supposed southern continent. He touched at Van Diemen's Land, quarrelled with the natives, and finding no fresh water, and the weather being stormy, he set sail for

Australasia. New Zealand, having added very little to the prior discoveries of Tasman.

In the year 1792, Rear-Admiral D'Entrecasteaux, having been sent out with two ships, *La Recherche* and *L'Esperance*, in search of the unfortunate *La Pérouse*, made the south coast of New Holland, which he explored as far as the Termination Island of Vancouver; the deficiencies of whose chart he was able to supply, by the state of the weather permitting him to keep the coast closer on board than the English navigator had been able to do. Termination Island was found to be the first of a large group laid down by Nuyts, whose accuracy is praised by the admiral, he having found "the latitude of Point Leeuwin and of the coast of Nuyt's Land laid down with an exactness surprising for the remote period in which they had been discovered." This liberal acknowledgment did not, however, prevent him from giving to the group of islands, which he only saw, but did not survey, the name of *Archipel de la Recherche*. But the most important discovery of D'Entrecasteaux was an inlet on the south coast of Van Diemen's Land, which was found to be the entrance into a fine navigable channel, running more than thirty miles to the northward, and there communicating with Storm Bay; containing a series of excellent harbours, or rather one continued harbour the whole way, from beginning to end. "The charts," says Captain Flinders, "of the bays, ports, and arms of the sea, at the south-east end of Van Diemen's Land, constructed, in this expedition, by Messieurs Beautemps, Beaupré, and assistants, appear to combine scientific accuracy and minuteness of detail with an uncommon degree of neatness in the execution. They contain some of the finest specimens of marine surveying, perhaps, ever made in a new country."

In 1800 Captain Baudin was sent out with two armed vessels, *Le Géographe* and *Le Naturaliste*, on a voyage of discovery nominally *round the world*, but actually, as appears from his instructions, to examine every part of the coasts of New Holland and Van Diemen's Land. The first volume of the account of this voyage was published by M. Péron, one of the naturalists, in 1807; the second never appeared. All the old names of the capes, bays, inlets, and islands, were unblushingly changed to those of Napoleon, his family, his marshals, and members of the Institute; and to 900 leagues of the southern coast, comprehending all the discoveries of Nuyts, Vancouver, D'Entrecasteaux, Flinders, Bass, and Grant, was given the general name of *Terre Napoleon*, while not 50 leagues of real discovery were effected which had not been anticipated by Captain Flinders, who, after losing his ship, and proceeding homewards, was scandalously detained as a prisoner in the Isle of France, "to give time for the previous publication of the voyage of M. Baudin, to prepossess the world that it was to the French nation only the complete discovery and examination of the south coast of Australia was due."

Captain Flinders, however, ultimately triumphed. After an unjust and cruel captivity of seven years, he arrived in England in 1810, and in 1814 published his discoveries in two volumes, accompanied with an atlas of charts, which may be held forth as models in maritime surveying. At this time not a single chart of coast, bay, or island, of Captain Baudin's discoveries had appeared, though shortly afterwards an atlas was published by Freycinet, the first lieutenant, differing in their form and structure very little from those of Captain Flinders, but bearing the names recorded in M. Péron's first volume. The frontispiece to this atlas affords an instance of that almost impious adulation which Buonaparte was in the habit of receiving from his creatures. An *eye*, having an N within it, darts its rays through a dark cloud overshadowing a globe with the

southern pole uppermost, on which is drawn the outline of New Holland, with this inscription, "*Fulget et ipso.*" *Australasia.*

It is to Captain Flinders that we owe the completion in detail of the survey of the coasts of New Holland, with the exception of the west and north-west coasts, which he was prevented from accomplishing by the loss of his ship. Dampier had said, in anchoring near the south end of De Witt's Land, behind Rosemary Island, which was one of an extensive cluster, "by the tides I met with a while afterwards, I had a strong suspicion that there might be a kind of archipelago of islands, and a passage possibly to the south of New Holland and New Guinea, into the Great South Sea eastward;" but whether it might be a channel or strait, or the mouth of a large river, he seems not to have made up his mind. Vlaming saw an opening 12 miles wide near the same place, and could find no anchorage. It has now been ascertained that there is no outlet into the great Ocean eastward, nor into the Gulf of Carpentaria, nor into Bass Strait; but the geographical problem yet remains to be solved, whether the opening in the coast behind Rosemary Island be not the mouth of a large river. *Le Géographe* and *Le Naturaliste*, under Baudin, stood along this coast, examined in a very slovenly manner some particular points, but assisted geography less than they perplexed it, by unwarrantably changing every old name for that of some of the upstarts created by the French revolution. Never, indeed, were two naval officers so ill selected for the purpose of discovery as Captains Baudin and Hamelin; but not so those in the scientific department, who, under every unfavourable and discouraging circumstance, effected more for physical science than could be expected. Except those parts therefore that were examined by Captain King, a great portion of the northern part of this coast may still be considered as *terra incognita*; and it is somewhat remarkable, that the local government of New South Wales, which, we believe, has under its command several colonial vessels, should not before this have taken occasion to ascertain this point, on which so many curious and unexplained phenomena in the geography and geology of the fifth continent depend. We are now, however, in a fair way of having our knowledge of the western side of New Holland considerably enlarged by the establishment of the new colony of Swan River, under the auspices of Captain Stirling of the navy; which, though not well adapted for an agricultural, there is every reason to believe, will turn out a prosperous pastoral settlement. Towards the end of 1830 the number of settlers amounted to not less than 2000 persons, with 3000 head of sheep, 500 head of horned cattle, and above 100 horses. The country is sandy and of light soil; but the herbage is nutritive, and the cattle thrive well upon it. The climate is excellent, and water is abundant and good. A bar across the mouth of the river prevents ships from entering Melville Water, which is extensive, and of sufficient depth for a first-rate man of war; but a little to the southward of it there is safe and extensive anchorage in Cockburn Sound. Along the coast whales are most abundant, and a fishery has already commenced. A succession of three ranges of hills, the first at thirty miles distance from the coast, has not prevented discoveries to the eastward of them. In the valleys among these hills is abundance of wood and pasturage, and beyond the third range has been discovered a river of considerable magnitude, running to the northward through a rich valley. This river will probably be found to terminate in Shark's Bay.

A discovery has also been made of a bay to the eastward of Cape Leeuwin, into which a river called Blackwood falls; and to the eastward of this is another inlet or estuary, into which several rivers fall; and farther to the eastward still is the station of King George's Sound, with

Australasia. its two harbours. All these are comprehended within, and connected with, the Swan River Settlement. Its position is highly favourable for a speedy communication with India and the Indian Islands, the Cape of Good Hope, and the Mauritius, and it bids fair to become a flourishing and important settlement. It is a remarkable fact, that in a period not far short of thirty years since the settlement of Port Jackson was first made, all beyond as many leagues was a complete *terra incognita* to the settlers, till not long ago, when Mr Evans, the land-surveyor, penetrated behind the hitherto impassable barrier, the Blue Mountains, to the distance of about 300 miles, in two separate journeys.

Journeys
in the in-
terior.

Of these journeys it may be necessary to give a brief abstract. On the 19th November 1813 Mr Evans left Emu Island in the Nepean, and returned on the 8th January 1814, having performed a journey of 154 miles nearly west. At the end of 48 miles he had cleared the ranges of mountains, which, he says, consist of granite, with loose flints and quartz pebbles strewed on the surface; and here, for the first time, he fell in with a small stream running to the westward. The farther he advanced the more beautiful the country became; both hill and dale were clothed with fine grass, the whole appearing at a little distance as if laid out into fields divided by hedgerows. Through every valley meandered trickling streams of fine water, all falling down towards the Fish River, so called by him from the vast abundance of fine fish resembling trout, which his party caught with ease whenever they had occasion for them. Many of the hills were capped with forest trees, chiefly of the Eucalyptus; and clumps of these, mixed with Mimosas and the Casuarina, were interspersed along the feet of the hills and in the valleys, so as to wear the appearance of a succession of gentlemen's parks. The river, which at first consisted of a chain of pools connected by small streamlets, had assumed in the neighbourhood of Macquarrie's Plains the character of a considerable stream, and had become unfordable, which made it necessary to construct a bridge of large trees to transport the people, the horses, and baggage. Evans says, the country was now more beautiful than he had ever seen. A fine river, running in a deep channel over a gravelly bottom, and its banks skirted with trees, excepting at the sloping points of hills round which it winded, and which were covered with a fine green sod down to the margin, intermixed with the white daisy;—all this, added to the temperate climate, put him in mind of England. Farther on, and before they reached Bathurst's Plains, the river was increased considerably in size, by the junction of another stream, which he called Campbell's River; and to the united streams he gave the name of Macquarrie's River, the general direction of which appeared to be to the northward of west. Fish continued to abound of the same kind as those first caught, but of a size from eleven to fifteen pounds each. Governor Macquarrie says, these fish resemble perch, are not unlike that usually called rock-cod, and have been caught from seventeen to twenty-five pounds weight each. Large herds of emus were seen crossing the plains, and kangaroos in great abundance; but not a native human being appeared until on his return, when, near Bathurst's Plains, two women and four children were come upon by surprise, and became so terrified that they fell down with fright. It was observed that both the women had lost the right eye. Evans makes Bathurst's Plains near 150 miles from Emu Island; but Governor Macquarrie, who subsequently visited this place, states the measured distance from Sydney town to be only 140 miles. It is represented as an eligible situation for establishing a settlement, as the land is excellent; plenty of stone and timber for building, but no limestone; abun-

dance of water, though the river, at the time of the governor's visit, just at the close of an unusually dry season, was reduced to a chain of pools, the intermediate channels being dried up.

In May 1815 Mr Evans was dispatched a second time, in order to follow the course of Macquarrie's River. He proceeded about 115 miles, from whence he could see across an extensive plain, 40 or 50 miles, at the extremity of which was a range of blue mountains, separated by an opening in the north-west, through which, he had no doubt, the river flowed; and he appears to have had as little doubt that it crosses the continent, and falls into the sea somewhere in De Witt's Land, probably through Dampier's Opening, behind Rosemary Island. A recent discovery has proved that this opinion is not well founded. In January 1831 an expedition undertaken by Captain Sturt has pretty nearly determined this point. With a view to determine the course of the Murrumbidgee River, or the outlet of its waters, this enterprising officer started a second time; and the result has been that, instead of the Macquarrie and the Lachlan, and other streams that run to the westward, falling into a great inland sea or extensive marsh, as was conjectured, their united waters constitute a large river, which, under the name of Murray, was found to turn to the southward, and empty itself into an extensive estuary, 60 miles in length by 30 or 40 in width. The river near the point where it fell into this lake or estuary was about 400 yards wide and 20 feet deep. The whole country on both banks was composed of undulating and picturesque hills, at the bases of which extended plains and valleys, within sight of many thousand acres of the richest soils.

The mouth through which the waters of the estuary communicated with the sea was in Encounter Bay, in long. 139. 40. E. and lat. 35. 25. 15. S., a little to the eastward of the Gulf of St Vincent, and round the point named Cape Jervis. The river was well stocked with fish, and its banks more populous than any other part of the country that had been traversed. Some accounts state the total number seen to have amounted to not less than 4000 souls. They could scarcely be brought to believe that the discovering party were of the same genus as themselves; they placed their hands against those of the strangers, in order to ascertain if the number of fingers on each corresponded. Nothing surprised them more than the act of taking off the hat, believing, it would seem, that this superstructure of *felt* formed a part of the strange animal that had come into their country.

That part of the country which was passed over by Evans and Oxley was but thinly peopled. The natives who were seen resembled, in their persons and features, those of Sydney, but spoke a different language; and they were better clothed, being well covered with kangaroo skins, sewed neatly together with the sinews of emus. They wore the fur side next the skin, and the outer or flesh side was very ingeniously marked with regular ornamental devices, among which the *cross* appeared to predominate. They were exceedingly terrified at the sight of Mr Evans on his horse, as they took the rider and horse to be one animal, and did not recover from their fright or surprise on seeing him dismount. When a little tranquillized, and more familiar, they were found to be a good-humoured, laughing people, exhibiting none of the savage and furious spirit of the natives of Sydney, excited no doubt by the settlers. They were attended with dogs not unlike the jackal, with which they catch kangaroos. The spears they carried were heavy and clumsily made, and they could only throw them to a short distance, something like the New Zealanders.

The country beyond Bathurst was even superior to that

Australasia. first explored. The vast herds of emus and kangaroos were truly astonishing. These animals, and the fish of the river, appeared to be the principal articles of subsistence for the natives. In one large plain, covered with kangaroos and emus, Evans discovered an immense quantity of a white substance, resembling comfits or sugar-plums, which he took to be manna, but which appears to be a pure saccharine substance, an exudation probably from some particular plant. He passed whole mountains of fine blue limestone, and picked up topazes, crystals, and other pebbles, such as are met with on the coast of Bass's Strait. He also mentions forests of pines, the trees forty feet in height without a branch. Governor Macquarie, however, observed, that as the soil and grass-lands improved, the timber trees decreased in size. (See the different works of Dalrymple, Burney, Cook, D'Entrecasteaux, and Flinders.)

General
view of
New Hol-
and.

If, however, but little is yet known of the interior of New Holland, and the detail of the western coast still requires to be filled up, the grand outline of this large island, or more properly continent, has been completed, and its limits correctly ascertained. It extends in latitude from Cape York, in $10^{\circ} 45'$ south, to Wilson's promontory, in $39^{\circ} 9'$ south; and in longitude from Dirk Hartog's Island, in Shark's Bay, in 113° east, to Point Look-out, in Glass-house Bay, in $153^{\circ} 35'$ east; the mean breadth from north to south being about 1200, and length from east to west 2100 geographical miles, making an area equal to about three fourths of the continent of Europe. A remarkable sameness in all the productions of the three kingdoms of nature prevails in every part of its extensive coasts, and as remarkable a difference in two of them (the animal and vegetable) from those of the rest of the world.

Natives.

The natives, wherever they have been met with, are of the very lowest description of human beings. In the journal of the Duyfhen, the north coast is described as thinly "inhabited by wild, cruel, black savages, by whom some of the crew were murdered;" and the ship Vianen, touching on the western coast about 21° south, observed "a foul and barren shore, green fields, and very wild, black, barbarous inhabitants." In 24° south, Polsert, who commanded the Batavia, saw four natives, whom he describes as "wild, black, and altogether naked, not covering even those parts which almost all savages conceal." Tasman "found in *Hollandia Nova*, in lat. $17^{\circ} 12'$ south, a naked black people, with curly hair, malicious and cruel, using for arms bows and arrows, hazagaeyes, and kalawaeyes." Dampier describes them as being "a naked black people, with curly hair, having a piece of the rind of a tree tied like a girdle about their waists, and a handful of long grass, or three or four green boughs full of leaves, thrust under their girdle to cover their nakedness;" that "the two fore-teeth of the upper jaw are wanting in all of them, men and women, old and young; neither have they any beards." And he remarks, "they have no boats, canoes, or bark-logs." The south coast is so barren, and the naked hillocks of sand so continuous, that there appears to be nothing for human inhabitants to subsist upon. "It is not surprising," says D'Entrecasteaux, "that Nuyts has given no details of this barren coast; for its aspect is so uniform, that the most fruitful imagination could find nothing to say of it." None of our navigators, however, saw more than the coast line, which is either of rock or hillocks of sand. But where the country begins to improve towards the eastward, in the neighbourhood of Kangaroo Island, Captain Flinders found not the least vestige of inhabitants; and, from the stupidity of the kangaroos on that island, "which," he observes, "not unfrequently appeared to consider us as seals," he concludes there either are no natives, or that they are igno-

rant of every kind of embarkation. Towards the north-*Australasia.* ern part of the eastern coast, the same navigator thinks they are somewhat superior to those near Sydney, having belts round the waist, and fillets about the head and upper part of the arm, associating in greater numbers, and dwelling in huts of a superior construction. They also catch fish with nets, which he thinks is alone a feature of distinction from those who only spear the fish, as a net requires more than one person to manage it, consumes much time in making, cannot easily be dragged about, and, in short, must occasion a sense of the advantage to be derived from mutual assistance, and suggest the necessity of a permanent residence. The native of the colony of Sydney we know pretty well to be a gloomy, solitary, unsettled being; seldom appearing, even in the town, without his spear, his throwing-stick, or his club. "His spear," says Colonel Collins, "is his defence against enemies. It is the weapon he uses to punish aggression and revenge insult. It is even the instrument with which he corrects his wife in the last extreme; for, in their passion, or perhaps oftener in a fit of jealousy, they scruple not to inflict death. It is the plaything of children, and in the hands of persons of all ages." Turnbull says, the natives of this part of New Holland are, beyond comparison, the most barbarous on the surface of the globe, and that the influence of European settlers has had no effect in rendering them more sensible of the benefits of civilization; that every day men and women are to be seen in the streets of Sydney and Paramatta naked as in the moment of their birth; yet he contends that they are far from being stupid; that they are the greatest mimics alive; and that the oddities, dress, walk, gait, and looks of all the Europeans of any rank, from the time of Governor Philip downwards, are so exactly imitated, as to form among them a kind of historic register of their several actions and characters; and they are great proficient in the slang language of the convicts. But this seems to be the sum total of all their acquisitions from European intercourse. In other respects they remain, generally speaking, the same untutored, unprotected, improvident, and comfortless savages we first found them. But why is this? Because no pains have been bestowed on their improvement; no kindness shown them to encourage that improvement. In the district under the command of Sir Edward Parry, the natives have been treated like human beings, are sensible of the advantages of civilization, and several of them have made considerable progress in reading and writing, attend the religious duties which the captain and his lady have regularly performed, and they vie with each other in being neat in their persons and clothing. They are described, however, as hideously ugly, with flat noses, wide nostrils, eyes sunk in the head, overshadowed with thick, black eyebrows; the mouth extravagantly wide, lips thick and prominent, hair black and clotted, but not woolly, the colour of the skin varying from dark bronze to jet black. Their stature is below the middle size. They are remarkably thin and ill made, their limbs small, and almost without any appearance of muscle. They live chiefly on fish, which they sometimes spear and sometimes net, the women on parts of the coast aiding to catch them with the hook and line. If a dead whale happens to be cast on shore, numbers flock to it from every part of the coast, just as the vultures smell out a dead carcass, and they feast sumptuously while any part of it remains. Those in the interior are stated to live on grubs, ants and their eggs, kangaroos when they can catch them, fern roots, various kinds of berries, and honey. These sylvan satyrs are described as having long and lean legs and arms, owing, as is supposed, to their climbing of trees, which they ascend by notches cut into them by stone hatchets, in which

Australasia. the great toe is placed, and by these means they ascend trees that are seventy or eighty feet in height.

To add to their natural deformity, they thrust a bone through the cartilage of the nose, and stick with gum to their hair, matted with moss, the teeth of men, sharks, or kangaroos, the tails of dogs, jaw-bones of fish, &c. and daub their faces and bodies with red and white clay, and scarify the skin in every part with sharp shells. The women and female children are generally found to want the first two joints of the little finger of the left hand; and the reason they assign is, that they would otherwise be in the way of winding the fishing-lines over the hand.

They have no fixed habitations, the climate generally allowing of their sleeping in the open air, in the crevices of rocks, or under the shelter of the bushes. Their temporary hovels consist of the bark of a tree, each hovel being just large enough to receive a single person; but to the northward, on the east coast, some were discovered a little larger, so that a family might, on an emergency, squeeze under one of them; they are, however, without furniture or conveniences of any description. They seem to have no idea of the benefits arising from social life; their largest clans extend not beyond the family circle, of each of which the eldest is called by a name synonymous with that of *father*. They are totally without religion, paying neither the least respect nor adoration to any object or being, real or imaginary. Hence they have nothing to prompt them to a good action, nothing to deter them from a bad one; hence murder is not considered as any heinous crime, and women think nothing of destroying, by compression, the infant in the womb, to avoid the trouble, if brought alive into the world, of carrying it about and finding it subsistence. Should a woman die with an infant at the breast, the living child is inhumanly thrown into the same hole with the mother, and covered with stones, of which the brutal father throws the first. They are savage even in love, the very first act of courtship, on the part of the husband, being that of knocking down his intended bride with a club, and dragging her away from her friends, bleeding and senseless, to the woods. The consequence is, that scarcely a female of the age of maturity is to be seen without her head full of scars, the unequivocal marks of her husband's affection. The nearest relations are also perpetually destroying each other, either by stratagem or open combat; for, savage as they are, they have a singular custom of expiating an offence, even murder, by the criminal exposing himself to as many of the injured family as may choose to stand forth and hurl their spears at him. From the moment that he is so dreadfully mangled that he can stand no longer, or has the good fortune to parry all their shafts, a reconciliation takes place, and friendship is restored. If the criminal refuses to stand this trial, he and all his family are considered as fair game to attack and murder wherever they are met with. The English used to attend these unequal combats, and thus gave countenance to a savage practice, which not unfrequently ended in the death of the person who was thus put on his defence. (See Collins, Flinders, Turnbull, &c.)

Animals.

If no very essential difference be perceptible in the moral and physical qualities of the man of New Holland and the rest of the species, except that which arises from the different circumstances under which they are placed,—if the rocks and mountains, and the earths, resemble nearly the inorganic substances that are met with in other parts of the world,—there is at least a very extraordinary and a distinct characteristic difference in both the animal and vegetable part of the creation, which makes a considerable class of subjects in both these kingdoms peculiar to New Holland. The quadrupeds

hitherto discovered, with very few exceptions, are of *Australasia*. the kangaroo or opossum tribe; having their hinder legs long out of all proportion when compared with the length of the fore legs, and a sack under the belly of the female for the reception of the young; of which family, though divided into different genera, there are at least fifty distinct species. They have rats, and dogs of the jackal kind, all exactly alike; and a little animal of the bear tribe, named *womat*; and these pretty nearly complete the catalogue of four-footed animals yet known on this fifth continent. There appears, indeed, such an apparent affinity of the natural objects in New South Wales, that Dr White observes, all the quadrupeds are like opossums, all the fish like sharks; and that every part of the land, all the trees, and all the grasses, resemble one another. There is, however, an animal which resembles nothing in the creation but itself,—which, being rejected by naturalists from the classes *mammalia*, *aves*, and *pisces*, must, we suppose, be considered as belonging to the *amphibia*,—we mean the *ornithorhyncus paradoxus*, “a quadruped with the beak of a bird, which is contrary to known facts and received opinions.” When the head of one of these beasts was brought to the late Dr Shaw of the British Museum, he suspected it as an idle attempt to impose on his judgment, and did not hastily believe that nature had set the bill of a duck on the head of a quadruped; but so it has since proved to be the case.

The birds are no less singular than the beasts, there being black swans and white eagles, the former everywhere in such multitudes as to spoil a proverb that had held good for two thousand years; and their song, if we may credit Mr Bass, “exactly resembles the creaking of a rusty sign on a windy day.” The *Mænura superba*, with its scalloped tail feathers, is perhaps the most singular and beautiful of that very elegant race of birds known by the name of *birds of paradise*; cockatoos, parrots, and parroquets, are innumerable, and of great variety. The mountain eagle is a magnificent creature; but the emu is perhaps the tallest and loftiest bird that exists, many of them standing full seven feet high.

The plants are no less singular than the animals. Of *Plants*. these Mr Brown has given a very curious and instructive account in his *Geographical and Systematical Remarks*, in the Appendix to Flinders's *Voyage*. He collected nearly 3900 species of Australasian plants, which, with those brought to England by Sir Joseph Banks and others, supplied him with the materials for a *Flora Terræ Australis*, consisting of 4200 species, referable to 120 natural orders; but he remarks, that more than half the number of species belong to *eleven* only of those orders. Of the *Eucalyptus* or gum-tree, the largest yet discovered, there are not fewer than 100 different species. “The *Eucalyptus globulus* of Labillardière,” says Mr Brown, “and another species, peculiar to the south of Van Diemen's Land, not unfrequently attain the height of 150 feet, with a girth near the base of from 25 to 40 feet.” Of this magnificent genus there are 50 different species within the limits of the colony of Port Jackson. Of the beautiful and elegant *Melaleuca* Mr Brown collected upwards of 30 species, all of which, with the exception of the two species *Leucodendron* and *Cajaputi*, appear to be confined to Terra Australis. The tribe of *Stackhouseæ* is entirely peculiar to that country. Of the natural order of *proteaceæ*, consisting of about 400 known species, more than 200 are natives of New Holland, of which they form one of its characteristic botanical features; the *Banksia*, in particular, being one of the most striking peculiarities of the vegetable kingdom. The *Casuarina*, of which 13 species have been discovered, is another characteristic feature of the woods and thickets of New Holland. The most ex-

Australasia. tensive genus, however, is the leafless *Acacia*, of which there are more than 100 species; and this, with the *Eucalyptus*, "if taken together," says Mr Brown, "and considered with respect to the mass of vegetable matter they contain, calculated from the size as well as from the number of individuals, are perhaps nearly equal to all the other plants of that country." The *Casuarina* and the *Eucalyptus* are represented as furnishing excellent timber for ship-building, and for all the purposes of domestic furniture and agricultural implements; and the gum of the *Eucalyptus* is medicinal,—that of one species might be employed as pitch. Freycinet says they procured a resinous substance from the *Xanthorrhoea*, which served them to caulk their vessels. The bark of a tree on the Hawkesbury is said to be as efficacious in tanning leather as the oak-bark; and a creeping plant (*smilax*) is used as a substitute for tea. Nutmegs were found by Flinders on the northern coast, but they were small, and had so little of an aromatic flavour, that Mr Brown gave the plant the specific name of *insipida*. Among the curious productions of the vegetable world is the *Cephalotus follicularis*, or pitcher plant, of which a very correct and detailed drawing is given in the Atlas to Flinders's *Voyage*.

General
view of
Van Die-
men's
Land.

II. Having marked the progressive discovery of this fair and fertile island, until it was ascertained to be such by Tasman, Marion, Furneaux, Cook, D'Entrecasteaux, Bass, and Flinders, we shall not think it necessary to notice the minor discoveries of Bligh, Hunter, Cox, &c. but proceed to give a general outline of its dimensions, surface, and natural productions. It is situated between the parallels of 41. 0. and 43. 32. S. lat., and 144. 32. and 148. 25. E. long.; its medial length from north to south being about 160, and breadth from east to west 145 geographical miles. Its surface possesses every variety of mountain, hill, and dale,—of forests and open meadows,—of inland lakes, rivers, and inlets of the sea, forming safe and commodious harbours,—that can render a country valuable or agreeable; and it enjoys a temperate climate, which is perhaps not very different from that of England, though less subject to violent changes. In May, corresponding to our November, Labillardière observed the mountains in the interior covered with snow. The western and southern coasts are bold, steep, and rocky; the latter terminating so abruptly as to appear as if it had been broken off, and the group of islands named De Witt's Isles, to the southward, twelve in number, formed out of the fragments. Cook found the cliffs on the eastern side composed of sandstone; but the vast buttresses that look towards the southern seas of ice are stated by Flinders to be composed of basaltic columns, appearing like so many stacks of chimneys. Labillardière found, near this southern extremity, a stratum of coal, $3\frac{1}{2}$ feet thick and 200 fathoms long, resting on sandstone.

The soil in general is represented as more productive than that of the east side of New Holland; and the island has the advantage of being intersected by two fine rivers, rising near the centre; the one named the Tamar, falling into Bass's Strait on the north, and forming Port Dalrymple; the other, the Derwent, which discharges itself into the sea on the south-east extremity, spreading its waters, in the first instance, over the Great Storm Bay, which communicates with North Bay, Norfolk Bay, and Double Bay, on the east, and with D'Entrecasteaux's Channel on the west. The Tamar in its course receives three streams,—the North Esk, the South Esk, and the Lake river; and the tide flows about 30 miles up the river, to the point where it is joined by the two Esks. At the head of the western arm of Port Dalrymple is situated York Town, on the skirt of a beautiful, rich, and

well-wooded country. There is also a town named Hobart Town, which is now the capital, on the right bank of the Derwent, about five miles inland. The country between these two towns was traversed in 1807 by Mr Grimes, who describes it to be everywhere rich and beautiful, abounding in grassy plains, marshes, and lakes, bounded on each side by hills, well clothed with wood, rising into high and rocky mountains.

The description given by D'Entrecasteaux of the channel that bears his name, and the surrounding shores, is grand and imposing, and corresponds generally with the following animated account of it from M. Péron, ten years afterwards. "Crowded on the surface of the soil are seen on every side those beautiful *Mimosas*, those superb *Metrosideros*, those *Correas*, unknown till of late to our country, but now become the pride of our shrubberies. From the shores of the ocean to the summits of the highest mountains may be observed the mighty *Eucalyptus*, those giant trees of Australasian forests, many of which measure from 162 to 180 feet in height, and from 25 to 30 and even 36 feet in circumference. *Banksia* of different species, the *Protea*, the *Embothria*, the *Leptosperma*, form an enchanting belt round the skirts of the forests. Here the *Casuarina* exhibits its beautiful form; there the elegant *Exocarpus* throws into a hundred different places its negligent branches. Everywhere spring up the most delightful thickets of *Melaleuca*, *Thesium*, *Conchyum*, *Evo-dia*, all equally interesting, either from their graceful shape, the lovely verdure of their foliage, the singularity of their corollas, or the form of their seed-vessels." (*Voy. aux Terres Australes*.)

All the navigators who have visited the southern part of Van Diemen's Land describe the natives as a mild, affable, good-humoured, and inoffensive people; with the exception of Marion, the effect of whose fire-arms, Labillardière thinks, had made them afraid of Europeans. Flinders and Bass conceived that the natives of this island were sunk still lower in the scale of human existence than those in the neighbourhood of Port Jackson, though they saw but one man, and he is described as having "a countenance more expressive of benignity and intelligence than of that ferocity or stupidity which generally characterized the other natives." They are obviously the same people as those of New Holland, and go entirely naked, both men and women; but their language is altogether different. They have the art, too, of striking fire with two flints, which is not known to the other Australasian islanders; and it is also singular that they set no value on iron. The women refused from Cook's people all presents, and rejected all their addresses, not so much from a sense of virtue, it was supposed, as from the fear of the men, of whom they stood in great awe. In some places were found miserable huts of twigs, and rude baskets, made of a juncus or rush; but these were all the signs that appeared of civilization. Cook, D'Entrecasteaux, and Baudin, all observed many of the largest trees with trunks hollowed out, apparently by means of fire; and as the hollow side invariably faced the east and south-east, the lee-side to the prevailing winds, it was concluded they were intended as habitations. In D'Entrecasteaux's Channel only were indications of huts made of the bark of the *Eucalyptus*, consisting of three rolls stitched together. (D'Entrecasteaux, Labillardière, Flinders, &c.)

III. This great island is, after New Holland, not only Papua or the first in point of magnitude, but claims a priority in New Guinea. discovery over that and every other island in the Australasian Sea. In the year 1526, when the Portuguese and the Spaniards were disputing their respective claims to the Spice Islands, Don Jorge de Meneses, of the former

Australasia. nation, had, in his passage from Malacca to the Moluccas, by extraordinary and accidental circumstances, discovered the north coast of Papua, so called, according to some, because the word signifies *black*, which was the colour of the natives, or *curled hair*, according to others. Meneses remained at a port called Versija till the change of the monsoon, and then returned to the Moluccas. The next navigator who touched at Papua was Alvarez de Saavedra, on his homeward voyage from the Moluccas in 1528, for New Spain; and from an idea that the country abounded in gold, he gave to it the name of *Isla del Oro*. From the resemblance of the natives to African negroes, being black, with short curly hair, the name was afterwards changed by the Spaniards to New Guinea, and not, as some have supposed, because it was thought that Guinea and Papua were situated under the same parallel of latitude; which, however, they certainly are, though one happens to be north and the other south latitude. He staid a month, and obtained provisions; but some Portuguese deserted with the only boat the ship had, and were left behind. They found their way, however, to Gilolo, and reported that Saavedra had been wrecked; but on his subsequent arrival they were tried, condemned, and executed. He is supposed to have added about 50 leagues of discovery to that of Meneses. In 1529 Saavedra sailed a second time from New Spain, and, according to Galvaom (or Galvano), followed the coast of Papua eastwards above 500 leagues.

In 1537 Gonzalvo and Alvarado were dispatched on discovery by the viceroy of Peru; but the former being killed in a mutiny, the crew chose another commander; and the first land they made was Papua. The ship was in so crazy a state that she was abandoned; the crew, only seven in number (the rest having died of hunger and fatigue), were made captives, and carried to an island called *Crespos* (curly-haired men), whence they were sent to the Moluccas and ransomed.

In 1545 Ynigo Ortiz de Retz, in his voyage from Tidore to New Spain, came to an archipelago of islands near the land of Papua; sailed 230 leagues along the north coast; and not knowing it had been before visited by Europeans, he called it *Nueva Guinea*, from the resemblance of the natives to those of the coast of Guinea.

In 1606 Torres made the east coast of New Guinea, in his way to the Moluccas, sailed westward 300 leagues, doubled the south-east point, sailed along the southern coast, saw the northern coast of New Holland, and passed the strait which now bears his name. He describes the coast of New Guinea as inhabited by a dark people, naked, except a covering round the middle, of painted cloth made of the bark of a tree. They had arms of clubs and darts ornamented with feathers. He fell in with many large islands, large ports, and large rivers. Towards the northern extremity he met with Mahomedans, who had swords and fire-arms.

In 1616 Schouten came in sight of a burning mountain on the coast of New Guinea, which he named Vulcan, and immediately after of the coast itself. The island was well inhabited, and abounded with cocoa nuts; but no anchoring ground could be found. The natives were black, with short hair; but others appeared of a more tawny colour, with canoes of a different shape. Among the islands in sight to the northward, four small ones continually smoked. On approaching the mainland, the natives, whom he calls real Papoos, came off, "a wild, strange, and ridiculous people, active as monkeys, having black curled hair, rings in their ears and noses, and necklaces of hogs' tusks." They had all some personal defect; one was blind, another had a great leg, a third a swelled arm; which made Schouten conclude that this part of the country was unhealthy, in

which he was more confirmed by observing their houses *Australasia.* built upon stakes eight or nine feet from the ground. At the two little islands of Moa and Insou, on the north-east coast, the friendly natives supplied them with abundance of cocoa nuts. At 28 leagues from Moa, Schouten fell in with a group of fourteen small islands covered with wood, but apparently uninhabited; but sailing to the northward, they were followed by six large canoes, the people in which were armed with javelins. Those in some canoes from another island were of a tawny complexion, had long curly hair, and appeared, by their persons and language, to be a different race from the natives of Papua: they had rings of coloured glass, yellow beads, and vessels of porcelain, which were regarded as "evidences of their having communication with the East Indies." Schouten's Island is the largest of this group. Tasman visited all these islands and the coast of New Guinea in 1643, and obtained vast numbers of cocoa nuts and bananas from the friendly natives of Moa and Insou. Tasman made no discoveries in this part of his voyage.

Our countryman Dampier saw the coast in 1699, but did not land: the natives came off to his ship, and he speaks in admiration of their large and picturesque *proas*. He discovered, however, a strait unknown before, which divides New Guinea from New Britain, and is now called after his name. Bougainville was less fortunate, when, in 1768, he touched on the coast of what he considered a separate island, and to which he gave the name of *Louisiade*: there is, however, some reason to believe that it is a continuation of New Guinea. D'Entrecasteaux, in 1792, passed along the northern coast of *Louisiade*, and through Dampier's Strait, but left the point of its identity with or separation from New Guinea undecided.

Sonnerat published *A Voyage to New Guinea*, though he evidently never was there, but describes the natives and productions from what he saw and from what he could collect at the island of Gibby, to the eastward of Gilolo.

Forrest, in 1775, anchored in the Bay of Dory, on the northern extremity of New Guinea, and collected some information respecting the inhabitants from a Mahomedan Hadji, who accompanied him. Captain Cook, also, in his first voyage in 1770, made the coast in about 6° 30' south latitude, a little to the northward of Cape Valscher, but did not bring his ship to anchor, on account of the hostility of the natives. A party landed near a grove of coconut trees, and not far from it found plantain and the bread-fruit tree. The breeze from the trees and shrubs is said to have been charged with a fragrance not unlike that of gum *benjamin*. Three Indians rushed out of the wood with a hideous shout, and ran towards the party; the foremost throwing something out of his hand which burnt like gunpowder, the other two hurling their lances at the same time. Before they reached the pinnacle, from 60 to 100 had collected, all stark naked; their appearance as to stature, colour, and crisped hair, resembling that of the New Hollanders. They let off fires by four or five at a time, but for what purpose could not be imagined. These fires appeared to be discharged from a piece of stick, probably a hollow cane; and the fire and smoke exactly resembled those of a musket, but without any report. Those who were on board ship, at a distance, concluded they had fire-arms; and even those in the boat might have supposed them firing volleys, had they not been so near as to ascertain that there was no report. Torres had observed something of the same kind in about 4° south latitude on the same coast, where, he says, the inhabitants were black, but better clothed than those southward; that among the weapons used by them were hollow bamboo sticks, which they filled with lime, and by throwing it out endeavoured to blind their enemies. This explanation, however, does

Australasia. not account for the *fire*. Forrest says that the Chinese from Tidore trade with Papua under Dutch colours; perhaps, therefore, gunpowder may be one of the articles carried by them in exchange for the slaves, ambergris, sea-slugs (*biche-de-mer*), tortoise-shell, loories, birds of paradise, &c. which they carry back to China.

General
view of
Papua.

If we suppose the Louisiade of Bougainville to be connected with New Guinea, this island extends in a south-east by east direction from the Cape absurdly called Good Hope, nearly under the equator, to Cape Deliverance, in $11^{\circ} 30'$ south, being in length about 1400, and medial breadth about 150 geographical miles. The accounts of all the navigators who have touched on the different parts of its coast describe it as a rich and magnificent country, containing, in all human probability, from its situation and appearance, the most valuable vegetable products of the Moluccas and the several Asiatic islands. Forrest found the nutmeg-tree on Manaswary Island, in the Bay of Dory; and he learned that a people in the interior, called *Haraforas*, cultivate the ground, and bring their produce down to the sea-coast; that they are very poor, and some of them have long hair; and that they live in trees, which they ascend by cutting notches in them. The people of New Guinea, in many parts of the coast, live in huts or cabins placed on stages which are erected on poles, commonly in the water, and probably as a protection against snakes and other venomous creatures, though Forrest seems to think against the *Haraforas*. On these stages they haul up their proas or canoes. These people are invariably described as being hideously ugly; their large eyes, flat noses, thick lips, woolly hair, and black shining skin, denoting almost to a certainty their African origin and their affinity with the natives of New Holland: but the difference of language, and the want of all the useful productions on the latter, which abound on New Guinea, induced Captain Cook to conclude that there is no intercourse between the two people. The Papuans increase their natural deformity by passing bones or pieces of stick through the cartilage of the nose, and frizzing out their curly locks like a mop, sometimes to the enormous circumference of three feet. They appear, however, to be one degree farther removed from savage life than the New Hollanders, having permanent houses, and both men and women wearing wrappers round the waist, which are among the articles brought to them by the Chinese and Malays.

Animals.

The only quadrupeds that are known to exist on this large island are dogs, rats, and wild hogs; but the feathered race are of great beauty and infinite variety. New Guinea is the native country of those singular and matchless beauties, the birds of paradise, which were once thought to have no legs, but to be always on the wing, and which are known by the name of *paxaros da sol*, birds of the sun. They are said to migrate in large flocks, in the dry monsoon, to the islands of Arroo, and other islands to the west and north-west of New Guinea. The great crown pigeon, parrots, loories, and minas, are natives of Papua.

The whole of this great country is indented with deep bays on every side, some of which nearly intersect the island; and the coast is surrounded on every side by a multitude of small islands, all peopled with the same description of blacks, excepting those already mentioned on the north-west, near the equator, most of which are under the government of Mahomedan Malays, with whom both the Dutch and Chinese have long kept up a considerable intercourse.

New Britain, New Ireland, and neighbouring islands.

IV. There can be little doubt that this extensive range of islands was partially seen by Le Maire and Schouten in 1616, who, after discovering the Groene Island and the Marquen Islands, steered along the northern coast of New Ireland, as did Tasman also in 1642. Dampier,

however, first ascertained New Britain to be an island distinct from New Guinea, by passing the strait which has since borne his name. He visited Port Montague on this island, and speaks of the black natives resembling the Papuans, their dexterity in managing their canoes, their woody hills, fertile vales, and delightful rivulets. He also anchored in Slinger's Bay, on New Ireland, which he conceived to be the same land with New Britain; but Carteret, in 1727, discovered and passed through a strait which separates them, and to which he gave the name of St George's Channel. The Admiralty Islands of Carteret, to the north-westward of New Britain, had previously been discovered by Schouten, and named the Twenty-five Islands. New Britain was seen by Roggewein in 1722, and by Bougainville in 1768.

D'Entrecasteaux, we believe, was the last navigator who passed along the north coast of New Britain, and through St George's Channel, which divides it from New Ireland, and from thence to the Admiralty Islands; and from his voyage, published by Rossel, together with Labillardière's and Carteret's, we shall extract a few gleanings.

The extent of New Britain and Ireland is not exactly known, nor have they been sufficiently explored to enable geographers to lay them down with accuracy, or even to state what number of islands the group consists of. One of considerable extent lies off the north-west end of New Ireland, which has been named New Hanover, and is itself surrounded by low woody islands. The whole group occupies a space between $2^{\circ} 30'$ and 6° of south latitude, and 149° and 153° of east longitude, and may probably contain an area not less than 10,000 geographical miles.

Carteret, in passing through the strait, saw but few natives on the south coast of New Ireland, who showed marked signs of hostility, and were armed with lances headed with flint; they had also slings and good fishing-tackle. They were black, and had woolly hair, but their lips, he says, were not thick, nor their noses flat; their cheeks were streaked with white, and their hair and beards were covered with a white powder. Their canoes were long and narrow, and had generally outriggers; one of them measured 90 feet in length, and was formed out of a single tree. The two large islands, and the whole group, in fact, were nearly covered with wood; and thick cocoa-nut groves skirted all the low parts of the coast. Labillardière says that New Ireland produces nutmegs; and he also mentions a new species of the Areca palm, 108 feet high, the stem consisting of hard solid timber.

The natives of the Admiralty Islands, lying to the north-west, were found by Carteret to be less black than those of New Britain and Ireland, with agreeable countenances, not unlike Europeans; their hair was curly, smeared with oil and red ochre, and their bodies and faces painted with the same material; the glans penis was covered with the shell called the *bullæ ovum*, serving the same purpose as the wooden sheath of the Caffres in South Africa, whom, indeed, they seem to resemble as closely as the natives of New Guinea do those of the western coast of Africa. The women wear a bandage round the waist. The central island is tolerably large, and of a beautiful appearance, clothed with the most luxuriant verdure, and cultivated to the very summit. Among the groves of cocoa-nut trees are numerous habitations, and the natives have evidently attained to a higher degree of civilization than their southern neighbours; they use earthen vessels, and chew the betel leaf with chunam or lime. This central island is surrounded by nearly thirty small flat islets of coral, and reefs in the various stages of their progress towards islets.

Proceeding to the westward and to the north-west, we meet with other little clusters of islands, as the Her-

Australasia.

Discovery.

General
description.

Natives.

Australasia. mites, the Portland, the Echiquier (chess-board), vulgarly called Exchequer Islands, all of which consist, like the Admiralty Archipelago, of a larger central island surrounded by a chain of islets and reefs, most of them covered with beautiful verdure. The natives of these groups, as they approach the equator, gradually assume a lighter colour and longer hair, till they lose entirely the negro character, and melt into that of Malays and other Asiatic islanders. (See Schouten, Dampier, Carteret, Labillardière, &c.)

Solomon's Islands.

V. This archipelago of islands was one of the first discoveries of the Spaniards in Australasia, though the credit of it is given to Alonzo de Mendana, who was sent on an expedition of discovery in 1567 from Callao by the viceroy of Peru. He anchored in a port on the island of Santa Ysabel, to which he gave the name of Porta de la Estrella; and he also built a brigantine to make further discoveries, in which she was particularly successful, having fallen in with no fewer than thirty-three islands, "of very fine prospect." Many of them were of considerable size, to which they gave particular names, as Galera, Buonavista, Florida, San German, Guadalcanar, San Christoval, Santa Catarina, and Santa Ana. Guadalcanar, however, was the most attractive, having a port which they named De la Cruz, and a river which they called Galego. Of this island Mendana took possession for the king of Spain. When the voyage was published, the name of Solomon's Islands was given to the group, "to the end that the Spaniards, supposing them to be those isles from whence Solomon fetched gold to adorn the temple at Jerusalem, might be the more desirous to go and inhabit the same;" but it has been said that Mendana's advice was, that they should not be colonized, "that the English, or others, who pass the Strait of Magelhanes to go to the Moluccas, might have no succour there, but such as they get from the Indians." The truth, however, is, that Mendana, on a second voyage for the discovery of the Solomon Islands, returned without being able to find them, which gave occasion to the remark, that "what Mendana discovered in his first voyage, he lost in his second." He discovered, however, in this second voyage, the great island of Santa Cruz, which is situated at the south-east extremity of Solomon's Islands, and may very fairly be considered as one of the group. This island, which has an excellent harbour, La Graciosa, was first revisited after Mendana's discovery by Carteret, in 1767, who changed its name to that of Egmont, and made it the principal island of a group which he called Queen Charlotte's Islands. Here Mendana died, and Quiros succeeded to the command; but the search for Solomon's Islands was abandoned when they were not more than 40 leagues from Christoval. It is a singular fact that Solomon's Islands, whose name was sufficient to tempt adventurers, were lost to Europeans for two centuries after their discovery, and that we know at present little, if any, more than Mendana gave to the world after his first voyage. They were revisited by Bougainville in 1768; by M. Surville in 1769, on a voyage from Pondicherry of mercantile speculation, and who, from a ridiculous mistake, called them the Archipelago of the Arsacides, to mark the natives as assassins; by Lieutenant Shortland of the British navy, in 1788, who chose to call them New Georgia; and frequently, since that time, by various British and French navigators;—still the little we know of them is from Mendana.

Natives.

Santa Ysabel, he says, was inhabited by people who had the complexion of mulattoes, with curly hair, and little covering to their bodies; who worshipped serpents, toads, and such like creatures; whose food was cocoa-nuts and roots; and who, it was believed, ate human flesh, "for the chief sent to the general a present of a quarter

of a boy, with the hand and arm." Buonavista is twelve leagues in extent, very fertile, and well peopled, the natives living in regular villages or towns. On Florida, twenty-five leagues in circuit, the natives dyed their hair red, collected together at the sound of the conch-shells, and ate human flesh. Sesarga was well inhabited, produced plenty of yams and bread-fruit, and here the Spaniards saw hogs. In the midst of the island was a volcano continually emitting smoke. They saw bats which measured five feet between the tips of the wings. At Guadalcanar they received in barter two hens and a cock, the first fowls that had been seen. At San Christoval the natives were very numerous, and drew up to give battle to the Spaniards, their arms being darts, clubs, bows and arrows; but they were dispersed by the fire of the muskets, which killed one Indian, and wounded others. In the neighbouring village was found a quantity of cocoa-nuts and almonds, sufficient to have loaded a ship. Santa Ana was well peopled and fertile. It has a good port on the east side, where the Spaniards were attacked by the natives, who wounded three of the invaders, while a dart pierced through the target and arm of the Spanish commanding officer. The blacks had boughs on their heads, and bands round their waists. The Spaniards observed here hogs and fowls.

VI. To the south-east of Solomon's Islands, and between New He. the parallels of 14° 30' and 20° south latitude, are found a number of islands, some of very considerable magnitude, called the New Hebrides or Hebudes. They were first discovered in 1606 by Pedro Fernandez de Quiros, who, with Luis Vaez de Torres, was sent by the king of Spain from Lima with two ships and a zabra (launch) to establish a settlement at the island of Santa Cruz, and from thence to go in quest of the Tierra Austral or southern continent. This voyage has been considered, and justly so, among the most celebrated undertaken by the Spaniards since the time of Magelhanes. In April 1606 they discovered an island, to which they gave the name of Santa Maria, from whence they saw another island to the southward, "so large," says Torres, "that we sailed for it." On the 2d May they anchored in a bay large enough to hold a thousand ships, to which they gave the appropriate name of San Felipe y Santiago. Quiros at once determined that he had now discovered the long-sought-for southern continent, and in this conviction named it the Australia del Espiritu Santo. Two rivers fell into the bay, one the Jordan, the other the Salvador. The surrounding country was beautiful, and is thus described by the historian of the voyage: "The banks of the rivers were covered with odoriferous flowers and plants, particularly orange flowers and sweet basil, the perfumes of which were wafted to the ships by the morning and evening breezes; and at the early dawn was heard, from the neighbouring woods, the mixed melody of many different kinds of birds, some in appearance like nightingales, blackbirds, larks, and goldfinches. All the parts of the country in front of the sea were beautifully varied with fertile valleys, plains, winding rivers, and groves, which extend to the sides of the green mountains." (Torquemada, as quoted in Burney's *Account of Discoveries in the South Sea*.)

Of this terrestrial paradise, which the Spaniards regarded as their own, it was intended to take immediate possession. They landed in great numbers; the islanders were also numerous, became alarmed, made them presents, and signified a wish for them to return to their ships. They, however, landed from their boats, on which the chief drew a line on the ground with the end of his bow, and made signs that the Spaniards must not pass that boundary. It is said that Torres, to show his contempt

Australasia. of the idea of being restrained by barbarians, immediately passed the line. A battle ensued, in which the chief was killed, and all the rest fled into the woods. This rash act, however, was fatal to the views of the Spaniards, who never afterwards could prevail on the islanders to have any friendly communication with them; and they left this country, after some ridiculous formalities of taking possession in the name of Philip III., and founding a city, dignified with the name of the *New Jerusalem*.

So anxious was Quiros of "adding the Australia del Espiritu Santo to the other possessions of the Spanish monarchy," that, after his return to Spain, he is said to have presented no less than fifty memorials to the king. One of these, which was printed at Seville, begins thus: "I, Captain Pedro Fernandez de Quiros, say, that with this I have presented to your majesty eight memorials relative to the settlement which ought to be made in *Australia Incognita*." In these memorials he enumerates the many valuable productions of this supposed southern continent,—cocoa-nuts, plantains, sugar-canes, yams, batatas, oranges, limes, papas, pumpkins, almonds, nutmegs, mace, ginger, pepper in great quantities, and woods for "building any number of ships." The animals are hogs, goats, and dogs; fowls, and a variety of useful birds; various good fish, and pearl oysters. The climate is described as so fine, with such a freshness in the air, that neither by labour, exposure to the sun, or rain, or dews, nor by intemperance, did any of the Spaniards fall sick; and among the natives many aged people were seen. They wear a covering round the middle: Torres says they are all black and naked. They are described by Quiros as corpulent and strong, cleanly, cheerful, sensible, and grateful; their houses stood on the ground, and not on poles, built of wood, and thatched. They weave nets, and make earthen vessels, have plantations inclosed with palisades, construct vessels which navigate to distant countries, and have places appropriated for burying the dead; and, he adds, as the last and decisive test of their progress in civilization, "they cut their hogs and make capons."

Descrip-
tion.
Natives.

This archipelago of islands, like that of Solomon, was lost to the world for a century and a half, when Bougainville revisited them in 1768, but, except landing on the Isle of Lepers, did nothing more than discover that the land was not connected, but composed of islands, which he called the *Great Cyclades*; which, on being more accurately and extensively explored by Cook in 1774, underwent another change to that of New Hebrides, which they now bear in all our charts. According to the survey of our great navigator, they consist of Tierra del Espiritu Santo, the largest of the whole, St Bartholomew, Mallicolo, the Isle of Lepers, Aurora, Whitsuntide, Ambrym, Apee, Paoom, Three-hills, Sandwich, Montagu, Hinchinbrook, Shepherd's Isles, Erromango, Tanna, Immer, Annatom, and Errovan. The two which are more particularly described are Mallicolo and Tanna, the natives of which differ remarkably in their persons and language; those of the latter having curly but long hair, dark but not black, and without any thing of the negro character in their features, which are regular and agreeable, their persons slender, active, and nimble. They were found to be hospitable, civil, and good-natured, but they displayed a jealousy of their visitors seeing the interior of the island, which could only be equalled in Japan or China. All the plantations were fenced, and laid out in a line; they consisted of sugar-canes, yams, plantains, bread-fruit, &c. The yams were remarkably fine, one of them weighing fifty-six pounds, every ounce of which was good; and they had pigs and poultry. The juice of the cocoa-nut and water appeared to be their only beverage. Their arms were clubs, darts, lances, and bows and arrows. Their canoes,

clumsily sewed together, had outriggers, and were worked by paddles and by sails. The men wore a wrapper round the loins, and the women a sort of petticoat reaching to the knee. *Australasia.*

The natives of Mallicolo are called by Captain Cook "an ape-like nation," the most ugly, ill-proportioned people he ever met with, and different from all others, diminutive in their persons, dark coloured, with black hair, short and curly, but not so woolly as a negro's; they had long heads, flat faces, and monkey countenances; and a belt round the waist, pulled tight across the belly, made them look not unlike overgrown pismires. The women were equally ugly; and the dress of both sexes was in other respects the same as that of Tanna, as were also the productions of the island. Their houses were low, and covered with palm thatch. (See Dalrymple, Burney, Cook, &c.)

VII. This large island, surrounded with coral islets and reefs, was wholly unknown till Captain Cook in 1774 fell in with the north-western extremity in steering south-west from Mallicolo, from which it is distant not more than about eighty leagues. He anchored within a small island called Balabea, and opposite to the district Balade. The great island extends between latitude 20° 5' and 22° 30', in the direction of north-west and south-east, about 250 miles long by 60 broad. The land bears a great resemblance to that of New South Wales, and many of its natural productions appeared to be the same, but the natives were different. They are represented as a strong, robust, active, well-made people, courteous and friendly, and not in the least addicted to pilfering, in which respect they differ from every other tribe of Australasia. They are nearly of the same colour as the natives of Tanna, and appeared to be a mixed race between that people and those of the Friendly Isles, or of Tanna and New Zealand, their language being a mixture of them all. Of the same disposition as the natives of the Friendly Islands, they were found to excel them in affability and honesty; and the women, like those of Tanna, were chaster than the females of the more eastern islands, not one of the ship's company having been able to obtain the least favour from any one of them. They wear a petticoat of the filaments of the plantain tree, "at least six or eight inches thick, but not one inch longer than necessary for the use designed." They paint and puncture their bodies, and wear ear-rings, and necklaces, and bracelets, of tortoise and other shells. Both men and women have good features and agreeable countenances; and some of the men measure in height six feet four inches. Their hair is frizzled out like a mop, and is very black, coarse, and strong, but different from that of a negro. The rough mop-heads make use of "scratchers," composed of a number of sticks of hard wood, about the thickness of knitting-needles, fastened together at one end like a sort of comb; the women have their hair cropped short. The men wear a wrapper round the loins, made of the bark of a tree. Their houses resemble bee-hives, with peaked roofs, entered by a hole just big enough to admit a man bent double. The sides are of spars and reeds, and both these and the roof well thatched with dry grass. They boil their roots and fish in earthen jars. They have nets made of plantain fibres, and the sails of their canoes are of the same material. These vessels consist of two trees fixed together by a platform. They have plantations of sugar-canes, plantains, bread-fruit, and cocoa-nut, but none of them very productive. The whole appearance of the country, indeed, is described as unable to support many inhabitants. The greater part of the visible surface consists of barren rocky mountains; and though the plains and valleys appeared to be fertile, Captain Cook was of opinion that "nature

Australasia. has been less bountiful to it than to any other tropical island we know in this sea."

D'Entrecasteaux passed the opposite extremity of New Caledonia in 1792, when on his search after the unfortunate La Pérouse, but was prevented by a barrier reef of coral from approaching the coast; and, in the following year, he visited Balade on the north-west. The account of the inhabitants, as given by Rossel and Labillardière, differs altogether from that of Cook. Instead of finding them friendly, honest, and inoffensive, they are described as the worst of cannibals, not only eating the flesh of their enemies, but feeding on little children, ferocious in their dispositions, the most audacious thieves, and the women the most shameless prostitutes. But their own account of their transactions there, the confidence with which they straggled over the country, and the readiness of the savages to serve them, by no means warrant the bad character they have thought fit to give them; and they had no more proof of their being cannibals than they had for accusing the people of Van Diemen's Land of the same practices, because the surgeon-major mistook the bone of a kangaroo for that of a young girl. They appear to have endeavoured by signs to extort a confession to this effect from the poor savages, who, on their part, were also persuaded that the French were the real cannibals. The charge brought against the women is grounded solely on two young girls having been prevailed on by some of the crew to expose what decency requires to be concealed, in return for some pieces of cloth or iron. Labillardière thinks the inhabitants, as well as the vegetable productions, resemble those of Van Diemen's Land. There was no want of different kinds of esculent plants, though a great scarcity prevailed from drought or other cause when they arrived. The young shoots of the *Hybiscus tiliaceus*, the fruit of the *Cordia sebestina*, the *Dolichos tuberosus*, *Helianthus tuberosus*, *Arum esculentum*, and *Macrorrhizon*, *Hypoxis*, *Aleurites*, figs, oranges, plantains, sugar-canes, cocoa-nuts, and the bread-fruit, all afforded them articles of food. Yet Labillardière says they eat steatite, and that he saw one man devour a piece of this stone as large as his two fists. They also eat a species of spider. They had lost the hogs which Cook left them, but some half dozen of cocks and hens were seen by the French. (See Cook, Labillardière, &c.)

New Zealand.

VIII. Though these islands geographically belong to Australasia, the natives are, in their physical character and language, Polynesians. They were first discovered on the 13th December 1642, by Abel Jansen Tasman, on his voyage of discovery from the Mauritius; and, on the 18th, the Heemskirk yacht and the fly-boat Zeehaan came to anchor in a bay to which they afterwards gave the name of Moordenaar's or Murderer's Bay, and to the island that of Staaten Land, in honour of the states-general, and in the possibility that it might join the Staaten Land to the east of the Tierra del Fuego. "It is a fine country," says Tasman, "and we hope it is part of the unknown south continent." The expedition of Hendrik Brower to Chili the following year cut off the latter Staaten Land from any continental connection, and the name of the former was then changed to that of New Zealand.

On the 19th a boat with thirteen natives came within a stone's throw of the Heemskirk. The language in which they hailed was unlike that of the Solomon's Islands, of which Tasman had a vocabulary. Their vessel consisted of two narrow canoes, joined together by boards, on which the people sat; their paddles, about a fathom long, were pointed at the end; their clothing appeared of mats or cotton, but their breasts were naked. They were invited on board, but in vain. The ships, however, were moved nearer in shore, upon which seven double vessels came off.

A boat, dispatched from one ship to the other, had previously been attacked. Three men belonging to the Zeehaan were killed, and one mortally wounded; one of the killed was dragged into the canoes. After this, despairing of getting water or provisions, they weighed and set sail, twenty-two of the native boats following them, eleven of which were full of people. The ships fired, and the canoes returned to the shore.

The next visitor, at the distant period of a hundred and twenty-seven years, was Captain Surville, who in 1769 put into a bay on the north-eastern extremity, and gave it the name of Lauriston Bay. In the same year Lieutenant (afterwards Captain) Cook of the Endeavour, made the land on the 6th of October, the enormous height of which became the subject of much conversation; and the general opinion was, that they had now discovered the *Terra Australis Incognita*. This voyage, however, and the circumnavigation of the islands of New Zealand, entirely subverted the theory of a great southern continent. In 1772 Captains Marion du Fresne and Crozet put into the Bay of Isles, where the former and some of the crew were murdered by the natives. In March 1773 Captain Cook in the Resolution, with Captain Furneaux in the Adventure, revisited New Zealand, where the latter had a whole boat's crew with a midshipman murdered by the inhabitants. In 1776 and 1777 a third visit was made to these islands by Captain Cook. In these several visits, accompanied as he was with men well versed in every branch of natural knowledge, there will be found in the *Voyages* of Cook and Forster every species of information that the ferocious disposition of the inhabitants made it practicable to collect.

The two great islands of New Zealand extend between latitude 34° and 48° south, longitude 181° and 194° east; that to the northward, called Eaheinomawe, is about 400 geographical miles long by 90 in medial breadth; the name of the southern island is Tavai Poenammoo, and it is about 450 geographical miles long by 95 broad; the former has a rich and fertile soil, well clothed with trees, some of them more than 20 feet in girth, and 90 feet high, without a branch. Some of them resembled spruce, and were "large enough for the mainmast of a 50 gun ship." The highest hills were covered with forests, the valleys with grass and shrubbery, and the plains were well irrigated with rills of clear water. The southern island is very mountainous; one peak, resembling that of Teneriffe, was estimated by Forster, but without sufficient data, at 14,000 feet in height; it was covered with snow in the middle of January. Both as to appearance and temperature, they may be considered as the British isles of Australasia. Fahrenheit's thermometer in February was never higher than 66°, and was not lower in June than 48°.

A great part of the western side of those islands had, however, a desolate and inhospitable appearance; exhibiting ranges of yellow sandstone, or white sand hills, with scarcely a blade of verdure. It is worthy of remark, that this extraordinary difference prevails between the two coasts of South Africa, the two coasts of New Holland, and the two coasts of Van Diemen's Land.

The natives are stout, well limbed, and muscular, vigorous and active, excelling in manual dexterity; their countenances intelligent and expressive, of an olive complexion, but not darker than a Spaniard. In the appearance of the women there is not much feminine delicacy; but on Cook's first visit they found them more modest and decent in their behaviour than any of the islanders they had met with. They were covered from the shoulders to the ankles with a sort of netted cloth made of the split leaves of the flax plant (*Phormium tenax*), the ends hanging down like fringes. A party once came upon some

Natives.

Australasia. women by surprise as they were fishing, naked, for lobsters, and "the chaste Diana, with her nymphs, could not have discovered more confusion and distress at the sight of Actæon, than these women expressed upon our approach." On the third visit, however, they had got rid of all their modesty, and a rusty nail was sufficient to purchase the last favour.

The black hair of the men is bound in a knot on the top of the head, that of the women is cropped; both sexes anoint their hair with rancid oil, and smear their bodies with grease and red ochre. The faces of the old men are covered with large furrowed black marks, generally spiral lines, and have a horrible appearance. The women wear in their ears pieces of cloth, feathers, sticks, bones, &c. and bracelets and anklets of bone, teeth, shells, &c. Captain Cook did not observe any appearance of disease, or bodily complaint, or eruption on the skin, or marks of any; and the most severe wounds healed most rapidly. Very old men, without hair or teeth, showed no signs of decrepitude, and were full of cheerfulness and vivacity. They are mild, gentle, and affectionate towards each other, but ferocious and implacable towards their enemies; and it unfortunately happens, that the little societies into which they appear to be divided, are in an almost perpetual state of hostility, which makes it necessary for them to dwell in *happahs* or villages, fortified with embankments, ditches, and *pallisadoes*. They give no quarter, and feast with apparent relish on the bodies of their enemies, which they cut up and broil in holes dug in the earth; they suck out the brains, and preserve the skulls as trophies. They made no hesitation in devouring human flesh in presence of the English officers, and their provision baskets had generally a head or a limb of a human subject.

The only quadrupeds on the islands are dogs, small and ugly, and rats, the former of which they eat, and with their skins cut into strips they adorn their clothing; but their principal food consists of fish, and the bruised roots of fern. They cultivate, however, and with great neatness, sweet potatoes, eddas, and gourds, all planted in regular rows; and Cook observed near the villages both privies and dunghills. Their houses have a ridge-pole to the roof, which, with the sides, are built of sticks and grass, and lined with bark; they sleep on the floors covered with straw; and the furniture consists of a chest to hold their tools, clothes, arms, and feathers, provision baskets, and gourds to hold water, which is their only beverage; the New Zealanders being among the very few people, civilized or savage, who are ignorant of the means of intoxication.

Their double canoes or whale boats are admirably constructed with planks from 60 to 70 feet in length, and their prows and sterns are tastefully and curiously carved and ornamented; all of which is performed by adzes and axes of a hard black stone, or green talc or jade, and with chisels of human bone or jasper. Of these materials also their offensive weapons are made: these are lances fourteen feet long, sharp at both ends, of hard wood neatly carved; and a battle-axe of jade or bone about a foot long. Their war canoes carry from 60 to 70 men each; they keep exact time with their paddles, singing, with great vociferation and distorted features, their savage war-song, when bound on any hostile expedition. Their war-dances are conducted in the same furious and extravagant style; the only musical instrument, if it can be called one, which they use, is a triton shell, which sounds like a cow's horn.

They have, however, a taste for music, and the women are said to sing in a soft, slow, and mournful cadence, making use of semitones. When their husbands are slain

Australasia. in battle, they cut their legs, arms, and faces, with bone or sharp shells; and there are few of them who do not wear scars on their bodies as testimonials of their affection and sorrow for their deceased friends.

The natives of New Zealand exhibit a strange mixture of civilized and savage life. It was hoped, from the state of their cultivated grounds, of which several hundred acres were seen, that presents of hogs, kids, and poultry, would have been most acceptable, and considerable numbers were left with them on the first and second visits of Captain Cook; but, excepting the cocks and hens, which had bred plentifully, and flew about wild in the woods, the others had been wantonly destroyed. In 1791 Vancouver touched at Dusky Bay, and remained there for some time, examining the bays and creeks in the neighbourhood; but he did not see one human being. And in 1793 D'Entrecasteaux passed between the Three Kings' Island and Cape Maria van Diemen, but had no other communication with the natives except in their canoes. Unlike in every respect to the Otaheitans, they have evidently a common origin; their language not differing more than the language of the two New Zealand Islands from each other. The few notions they have of superior beings also accord with those of Otaheite. (See Cook's *Voyages*.)

A missionary of the name of Marsden, from merely seeing some New Zealanders in New South Wales, had the hardihood to accuse Captain Cook of having drawn "a false picture of the New Zealanders." He undoubtedly thought so, and went to the islands with a view of converting the natives to Christianity. He soon, however, abandoned this "noble race of men," as he calls them, being unable, by his own account, "to lay the first stone;" consoling himself for his disappointment by the reflection that "the pious Israelites could not build the walls of Jerusalem without holding the sword in one hand and the trowel in the other." Captain Cook's accuracy is too well established to be shaken by such authority. The following horrible transaction proves how well he described the character of these cannibals. In December 1809, the ship *Boyd*, from Port Jackson, was at Wangararoa, in the Bay of Islands, and admitted, without due caution, too large a number of natives on board, when the crew were suddenly attacked, overpowered, and slaughtered. Captain Alexander Berry, of the ship *Edinburgh Castle*, being on the coast, was soon after apprized of this horrible event; and, proceeding to the bay, found the remains of the *Boyd*, which had been burned by the savages. On landing, he discovered that the massacre had been directed by Tippihaee, the old chief who had been so much caressed at Sydney. The bones of the unfortunate men lay scattered on the ground, where their bodies had been devoured by the savages. Sixteen were murdered and cut up on the deck of the vessel; five others, who had fled for safety upon the yards, were told by the old cannibal, that if they would come down their lives should be spared, which, after some hesitation, they consented to do. They were sent on shore, and in five minutes after their dead bodies lay on the beach. The only survivors which Captain Berry contrived to save were, a woman, two children, and a boy. Well might Captain Berry conclude the narrative of his horrid murder by an admonition, "Let no man trust a New Zealander."

Commerce, however, that great civilizer, has done more for the Zealanders than the missionaries could effect. An active and increasing trade is carried on between these islands and New South Wales and Van Diemen's Land; and the southern whale-fishery ships are constantly calling there for refreshments. The result has been not only an improvement in the condition of these islanders, but a

Australasia. softening down of their ferocious disposition, and a steady march in progressive civilization.

To the eastward of New Zealand is an island of considerable extent and well peopled, discovered by Mr Broughton in 1791, when on a voyage round the world with Vancouver. He called it Chatham Island. The people and the productions are the same as those of New Zealand. (See Vancouver's *Voyage*.)

Lord Auckland's group of islands directly south of the south cape of Tavaia Poenammoo, one of the New Zealands, named Lord Auckland's Group by the discoverer, Mr Bristow, master of a South Sea Whaler, in gratitude to the nobleman whose name they bear, for having, when a boy, procured him admission into the school of Greenwich Hospital. This group, seven in number, was first seen on the 10th of August 1806; and on the 20th of October 1807 Captain Bristow came to anchor with his ship, the Sarah, in a fine harbour on the largest island, which he called Enderby, and to the harbour he gave the quaint name of Sarah's Bosom. They are situated in lat. $50^{\circ} 40'$ south, and long. $166^{\circ} 35'$ east. Wood and water being plentiful and easily procured, they are represented as holding out, in this desolate and remote region, considerable advantages to the southern whale-fishery. The climate, however, is unusually severe, and the weather tempestuous. In the middle of summer (December) every day was attended with snow, sleet, or rain. Yet this severity of climate appeared to make no unfavourable impression on the vegetable productions, as the woods were covered with verdure as early in the spring as October. He observed four kinds of timber trees, the principal of which was said to be mangrove, growing to the height of 30 or 40 feet; but the trunks were so twisted and turned by the violent winds that it was difficult to find a straight piece of ten feet in length. There was no want of shrubbery and herbaceous plants; there were neither men nor quadrupeds of any kind, but seals, sea-elephants, and sea-fowl, in great plenty. The woods abounded with a variety of singing birds with sweet melodious notes, and among them was a species of lark; wild ducks, teals, and snipes, were plentiful; and he caught a kind of rock-cod with the hook and line.

To the southward of the group another small island was discovered in 1811, to which was given the name of Campbell's Island; and to the south-west of them Macquarrie's Island, in latitude 55° south and longitude 160° east. Several other islands are scattered about those of New Zealand; Chatham Island to the eastward of it, and a group of small ones near it, seen by Cornwallis in 1807; Bounty Island to the south-east; and to the southward of the latter a little island which, from its position with regard to England, has been named Antipodes Island. (Bristow's *MS. Letter*.)

Kerguelen's Land. IX. Between the parallels of $48^{\circ} 30'$ and 50° south, and longitude 69° east, lies the barren and uninhabited Land of Kerguelen, so named from the French officer who first discovered it in 1772, and who, on a second visit in 1773, discovered some small islands near it, but on neither occasion was able once to bring his ships to an anchor upon any part of the coast. Captain Cook was more fortunate. He had heard of Kerguelen's discovery at the Cape of Good Hope, and wondered he should not have seen this land when he passed it so closely in 1770. In 1776, however, he fell in with these islands, and as no account of Kerguelen's voyage had been made public, he gave new names to each island. Speaking of the main island, "I should," says Cook, "from its sterility, with great propriety call it the *Island of Desolation*, but that I would not rob M. de Kerguelen of the honour of its bearing his name." He changed, however, the *Baie de l'Oiseau* of the

French, where they had landed in a boat and lodged a piece of parchment in a bottle, into *Christmas Harbour*; and called a round high rock Bligh's Cap, which had been named by M. de Kerguelen the Isle of Rendezvous,—although, says Cook, "I know nothing that can rendezvous about it but fowls of the air; for it is certainly inaccessible to any other animal." Kerguelen thought he had discovered the *Terra Australis Incognita*, but Cook soon determined that it was of no great extent.

The hills were but of a moderate height, and yet in the middle of summer were covered with snow; not a shrub was found on this island, and not more than 17 or 18 different plants, one half of which were either mosses or grasses. The chief verdure was occasioned by one plant not unlike a saxifrage, spreading in tufts, and forming a surface of a pretty extensive texture, over a kind of bog or rotten turf: the highest plant resembled a small cabbage when shot into seed, and was about two feet high. No land animals were met with, but great plenty of the ursine seal (*Phoca ursina*). Penguins were very abundant, as were also shags, cormorants, albatrosses, gulls, ducks, petrels, and sea-swallows. A few fish of the size of a had-dock were taken with the line, and the only shell-fish were a few limpets and muscles.

The steep cliffs towards the sea are rent from the top downwards, but whether by rains, frost, or earthquakes, could not be determined. The productions of the hills were composed chiefly of a dark blue and pretty hard stone, intermixed with small particles of glimmer or quartz. Lumps of coloured sandstone, and of semitransparent quartz, are also common. Nothing appeared like an ore or metal of any kind. (Cook's *Third Voyage*, vol. i.)

X. These small uninhabited islands are interesting only in a geological point of view. Situated in the midst of the great Indian Ocean, at the distance of 2000 miles from the nearest land, and removed but 18 or 20 miles from each other, they have no common point of resemblance; the one being the product of a volcanic eruption scarcely yet cooled, with a few mosses and grasses on its surface; the other composed of horizontal and parallel strata of rock, covered with frutescent plants—an appearance which led the scientific gentlemen in D'Entrecasteaux's expedition to conclude that an organization so regular could not proceed from a volcanic origin. A French seal-catcher from the neighbouring island had set fire to the shrubbery, which continued to burn when the navigators passed the island; and imagining that they saw pits of smoke issuing from the crevices between the strata, some of them were disposed to consider this circumstance as infallible indications of subterranean fire. Perron, the seal-catcher above mentioned, with the gentlemen of Lord Macartney's embassy, who explored the southernmost island, Amsterdam, says that the shores of St Paul's abounded with pumice stone; but the presence of this light material is by no means an infallible criterion of a proximate eruption.

Of the recent creation of Amsterdam there can be little doubt; indeed, it is scarcely yet cooled, and is altered considerably since its first discovery by Vlaming in 1696. From every part of the sloping sides of the crater, which is nearly 1000 yards in diameter, and into which the sea has forced its way, either smoke, or hot water, or hot mud, is seen to issue; and everywhere is felt a tremulous motion, and a noise heard like that of boiling water. In many parts of the crater, in the centre of which the water is 174 feet deep, the sea-water is tepid from the hot springs below; and numbers of these springs are found on the margin, below the high-water mark, of various temperatures, from 100° to the boiling point. One very copious spring, slightly chalybeate, issues, in a copious

Australasia. stream, into the crater, nearly on a level with the lowest state of the tide. These springs cannot possibly descend from the summit of the island, the highest part of which is the edge of the crater, about 600 feet; and the whole area of the island is not more than eight square miles, a surface totally inadequate to collect and condense the clouds, so as to produce these permanent springs. Why some modern geologists, and among them M. de Humboldt, should doubt of sea-water being converted into steam, and undergoing the process of distillation by subterranean fire, we are at a loss to know; or in what other manner they would account for such large and permanent streams of fresh water so situated as those are of Amsterdam Island.

Another singularity which this island presents is in its mosses and grasses, which are all European. To these may be added the *Sonchus oleracea*, or sow thistle, and the *Apium petrosilenum*, or parsley; and the common *Lycopodium*, or club-moss, which grows luxuriantly on the bleak heaths of North Britain, seems to thrive equally well on the boggy soil of Amsterdam, heated, at the depth of a foot below the surface, to the temperature of 186° of Fahrenheit's scale.

The crater abounds with an excellent perch of a reddish colour, which is easily caught with the hook, and may be dropped at once into one of the hot springs on the margin and boiled alive; and, so caught and dressed, we are told it affords an excellent repast. The bar across the mouth of the crater is represented as one mass of cray-fish; and in the sea, outside the bar, are vast multitudes of whales, grampuses, porpoises, seals, and sea lions, so as to be dangerous for boats to pass. It was the same in Vlamming's time, who "found the sea so full of seals and sea lions that they were obliged to kill them to get a passage through; when they steered from the shore there was also an astonishing number of fish."

Coral reefs and islets in the Australasian Sea.

XI. From the volcanic island of Amsterdam, we must now take a glance of those innumerable low islands and reefs of rocks which are scattered over the greater part of the Australasian Sea to the eastward and northward of New Holland, and which are produced by an operation of nature different from that which lifted up Amsterdam; less violent, indeed, and with less eclat than the latter, but equally, if not more firmly established on the solid foundations of the deep abyss. A volcanic island not unfrequently breaks down its supporters, and sinks back into the cavity out of which it was hurled, as was recently the case with the Sabrina Island, near St Michael's; but the island of coral, created by slow and imperceptible degrees, hardens with time, and becomes one solid mass from the summit to the base.

We know very little as yet of the nature of the marine polypi that construct these wonderful fabrics, but we cannot be blind to the effects of their operations. Throughout the whole range of the Polynesian and Australasian islands, there is scarcely a league of sea unoccupied by a coral reef or a coral island; the former springing up to the surface of the water perpendicularly from the fathomless bottom, "deeper than did ever plummet sound;" and the latter in various stages, from the low and naked rock, with the water rippling over it, to an uninterrupted forest of tall trees. "I have seen," says Dalrymple, in his *Inquiry into the Formation of Islands*, "the coral banks in all their stages; some in deep water, others with a few rocks appearing above the surface: some just formed into islands, without the least appearance of vegetation; others with a few weeds on the highest part: and, lastly, such as are covered with large timber, with a bottomless sea at a pistol-shot distance." In fact, as soon as the edge of the reef is high enough to lay hold of the floating seawreck, or for a bird to perch upon, the island may be said to commence. The dung of birds, feathers, wreck of all

kinds, cocoa-nuts floating with the young plant out of the shell, are the first rudiments of the new island. With islands thus formed, and others in the several stages of their progressive creation, Torres Strait is nearly choked up; and Captain Flinders mentions one island in it covered with the *Casuarina*, and a variety of other trees and shrubs, which give food to paroquets, pigeons, and other birds, to whose ancestors it is probable the island was originally indebted for this vegetation. The time will come, —it may be ten thousand or ten millions of years, but come it must,—when New Holland, and New Guinea, and all the little groups of islets and reefs to the north and north-west of them, will either be united into one great continent, or be separated only by deep channels, in which the strength and velocity of the tide may obstruct the silent and unobserved agency of these insignificant but most efficacious labourers.

A barrier reef of coral runs along the whole of the eastern coast of New Holland, "among which," says Captain Flinders, "we sought fourteen days, and sailed more than 500 miles, before a passage could be found through them out to sea." Captain Flinders paid some attention to the structure of these reefs, on one of which he suffered shipwreck. Having landed on one of these creations, he says, "we had wheat sheaves, mushrooms, stags' horns, cabbage leaves, and a variety of other forms, glowing under water, with vivid tints of every shade betwixt green, purple, brown, and white." "It seems to me," he adds, "that when the animalcules which form the coral at the bottom of the ocean cease to live, their structures adhere to each other, by virtue either of the glutinous remains within, or of some property in salt water; and the interstices being gradually filled up with sand and broken pieces of coral washed by the sea, which also adhere, a mass of rock is at length formed. Future races of these animalcules erect their habitation upon the rising bank, and die in their turn, to increase, but principally to elevate, this monument of their wonderful labours." He says that they not only work perpendicularly, but that this barrier wall is the highest part, and generally exposed to the open sea, and that the infant colonies find shelter within it. A bank is thus gradually formed, which is not long in being visited by sea birds; salt plants take root upon it, and a soil begins to be formed; a cocoa-nut, or the drupe of a pandanus, is thrown on shore; land birds visit it, and deposit the seeds of shrubs and trees; every high tide and gale of wind add something to the bank; the form of an island is gradually assumed; and last of all comes man to take possession.

If we should imagine one of these immense coral reefs to be lifted up by a submarine volcano, and converted into an insular or continental ridge of hills, such a ridge would exhibit most of the phenomena that are met with in hills of limestone.

It is worthy of remark, that, in this great division of the globe, fully equal in extent to that of Europe, there is no quadruped larger than the kangaroo; that there is none of a ferocious character, and, in many of the islands, none of any description. Man only in Australasia is an animal of prey; and, more ferocious than the lynx, the leopard, or the hyæna, he devours his own species, in countries too where nature has done every thing for his comfort and subsistence. The consequence is, that population is so much checked and thwarted, that the number of all the natives who have been seen on the coasts of all the islands, from the first discovery to the present time, would not in the aggregate amount to 20,000 souls. The only hope of improvement must depend on the future colonization of these healthful and fertile regions of the globe by some European power. (M.)

A U S T R I A.

Austria.

THIS great empire is situated nearly in the centre of Europe, extending from the 44th to the 51st degree of north latitude, and from the 8th to the 26th degree of east longitude. Its configuration is irregular, but its extent corresponds to that of an oblong of fully 600 miles in length from east to west, and above 400 miles in breadth from north to south. Compared with France, the Austrian dominions have a form nearly as compact, but their frontiers are by no means so strongly defined, nor so well guarded by physical barriers. France resembles a five-sided figure, having on three sides the sea, and on the other sides the Pyrenees, the Alps, and the Vosges; while in Austria the chief ranges of mountains are in the interior. In extent of surface, the Austrian dominions considerably exceed those of France, for they cover a space of no less than 260,000 square miles. They comprise a remarkable diversity of tribes, and even nations, differing from each other in language, habits, religion, and comparative civilization.

The component parts of this great empire consist of six countries bearing each the name of kingdom, viz. Hungary, Bohemia, Galicia, Lombardy and Venice, Illyria, and Dalmatia; one archduchy, Austria; one principality, Transylvania; one duchy, Styria; one margraviate, Moravia; and one county, Tyrol. We shall begin with an historical notice of this empire, that our readers may have a distinct view of two important subjects; first, of the means by which Austria, at first a small state, progressively rose into importance; and, next, of those resources by which she withstood the reverses sustained in her long contest with revolutionary France.

History.

The cradle of Austrian power was the fertile tract lying along the southern bank of the Danube to the eastward of the river Ens. It is said to have been overrun and partly colonized by Germans under Charlemagne; but be that as it may, after the empire of Germany was constituted in the ninth century, the district in question, afterwards called Lower Austria, was declared a military frontier for repelling the incursions of the Huns and other barbarous tribes to the eastward. It was called *Ost-reich*, the east country, from its position relatively to the rest of Germany; and its governor received from the head of the empire the title of margrave (in German *mark-graf*, or lord of the marches), which his descendants bore for centuries without anticipating the future greatness of their house. Towards the middle of the twelfth century their territory received an important accession in the province west of the Ens, which, from its vicinity to the Alps, and the greater elevation of its surface, was called Upper Austria. The governors of this augmented domain were now raised by the emperors of Germany from the humble rank of margrave to that of duke; and it was one of their number, Duke Leopold, who, towards the end of the twelfth century, ungenerously detained our Richard I. in confinement on his return from the Holy Land. It was at this time also that the important province of Styria came to the dukes of Austria by bequest. Hitherto the ducal residence had been in a castle on the high ground of Kahlenberg, near Vienna; but it was now removed to that city. In 1246 the male branch of the ducal line, originally from Bamberg in Franconia, became extinct, and Austria underwent a long interregnum. The reigning emperor of Germany declared both that duchy and Styria to have lapsed to the imperial crown,

and appointed a lieutenant (*statthalter*) to govern them on the part of the empire. But claims to the succession were brought forward by descendants of the female branch of the Bamberg line; and after various contests, Ottocar, son of the king of Bohemia, was, in 1262, duly invested with the government of Austria and Styria. Carinthia, Istria, with part of Friuli, soon after devolved on Ottocar by succession; but he forfeited all these advantages by his imprudence in refusing to acknowledge as emperor Rodolph of Hapsburg, who had been regularly elected to that high station. Hostilities ensued; the talents of Rodolph prevailed; and, in 1276, Ottocar was obliged to renounce his title to Austria and its appendant states. Notwithstanding this renunciation, Ottocar re-entered Austria with an army, but soon after fell in battle. The ducal throne being then vacant, Rodolph vested the succession to it in his sons; and having obtained the sanction of the electors of the empire to that important act, the reign of the Hapsburg dynasty over Austria commenced in 1282.

In the beginning of the following century the dukes of Austria lost a part of their Swiss territory by the insurrection of the cantons. This they never recovered; but in 1364 they acquired Tyrol; and Austria, hitherto known only as a remote province, little connected with the improved part of Germany, was soon after brought into contact with the general politics of the empire. The rank of emperor of Germany had been held successively by Saxon, Franconian, Suabian, and Bohemian princes, Austria having as yet supplied only one of the number (Albert I.); but, in 1438, another Albert, duke of Austria, was raised to that dignity, and, from close connection with Bohemia and Hungary, the power of Austria became so much greater than that of any other state in the empire, that from 1438 the imperial crown was regularly vested in the chief of the Austrian family. In the latter part of the century of which we are treating (the fifteenth), Maximilian I., an emperor of the Austrian line, made great additions to the power of his house by matrimonial connections, having himself espoused the heiress of the Netherlands, and afterwards married his son to the heiress of the crown of Spain. Of the latter marriage the issue was the well-known Charles V., who held the crown of Spain by inheritance, and the empire of Germany by election. Several years after his election, viz. in 1527, on the death of the king of Hungary and Bohemia, these extensive countries, formerly held by the house of Austria, reverted to it, along with Moravia, Silesia, and Lusatia, and were all governed by Ferdinand, a younger brother of Charles. Such were the countries directly or indirectly subject to the sovereign who carried on such obstinate conflicts with France, and was accused, like Louis XIV., of aiming at the sovereignty of Europe.

But the dominions of Charles V. did not long remain under one ruler. Spain was made over to his son Philip, along with the Netherlands; whilst Austria, Hungary, and his German states, were vested in his brother Ferdinand. These formed a splendid possession, but their efficiency in a political sense was not at all proportioned to their extent. A long time elapsed before Hungary and the eastern provinces became cordially attached to the imperial family. The treatment they in general experienced from their sovereigns was far from conciliatory, and the vicinity of the Turks afforded a ready support to insurgents.

Austria.

Austria.

Meanwhile, in the north of Germany, the religious antipathy of Catholics and Protestants led first to repeated dissensions, and eventually to the obstinate and sanguinary contest known from its duration (from 1618 to 1648) as the Thirty Years' War. On the one side were the Catholic princes of the empire, with Austria at their head; on the other, Saxony and the Protestant states, assisted at one time by Sweden, and subsequently by France. The most distinguished commanders were Gustavus Adolphus on the part of the Protestants, and, on that of the Catholics, Wallenstein the Austrian. Both were greatly superior to the age in which they lived, and evinced, at the battle of Lutzen, fought in 1632, talents not inferior to those displayed on the same fields in 1813. Wallenstein survived his illustrious opponent, but his end was tragical: he met a violent death by order of his imperial master, against whom he had ventured to conspire. The war was at last ended by the peace of Westphalia, by which Austria was obliged to relinquish Lusatia to Saxony, and Alsace to France.

The peace of Westphalia, like that of Utrecht in a subsequent age, restored tranquillity throughout Europe. It continued many years, and might have lasted much longer, had not the ambition of Louis XIV. alarmed the neighbouring states, and obliged them to look for safety in arms. Belgium, held at that time with a feeble hand by Spain, was the prize at stake; and the dread of that fertile and populous country falling into the power of France called forth the greatest efforts on the part of both Austria and Holland, which, from the extent of its financial means, was at that time a power of great influence. Louis was surrounded by able generals and well-disciplined armies. Flattered with the prospect of success, he attempted the conquest of the Netherlands in no less than three wars, in two of which (those begun in 1672 and 1689) Austria bore a principal part. In the last she received the co-operation of England, which then, for the first time, came forward as a principal in continental coalitions, contributing largely both in troops and subsidies. The chief scenes of conflict were the Netherlands and the banks of the Rhine. The French, acting with all the advantage of unity, had frequently the superiority in action; but the allies, numerous and resolute, were never discouraged by defeat. At last, in 1697, came the peace of Ryswick, which left, as peace often does, the contending parties in nearly the same relative positions as at the outset of the contest. They had the satisfaction, however, of having compelled the aspiring Louis to stop short in his encroachments and schemes of aggrandizement.

But with so restless a prince at the head of a population of 20,000,000, peace could not be of long continuance; and, on the death of the king of Spain, Austria, England, and Holland, found it again necessary to take the field. The question now related not merely to the Netherlands, but whether a French or an Austrian prince should succeed to the crown of Spain. Hence the name of War of the Succession, given to this long contest, which, beginning in 1701, lasted no less than twelve years. The superiority in military skill was now for the first time on the side of the allies. The Austrians and other Germans, subsidized by Holland and England, were led to repeated victories by Eugene and Marlborough. France sent forth numerous armies, and showed, in Villars and Vendome, generals worthy of the better days of Louis; but in Italy and the Low Countries the allies were completely successful; and it was in Spain only that they failed. Such was the state of circumstances in 1711, when the death of the reigning emperor took place unexpectedly, and the election to that dignity fell on his brother, who had been

destined by the allies to the throne of Spain. The prospect of the junction on one head of the crowns of Spain and Austria brought to recollection the ambitious projects of the emperor Charles V., and inclined many who had supported the war from a dread of France, to consider the transfer of Spain to a grandson of Louis XIV. the less dangerous alternative of the two. This, joined to the change of ministry in England, the removal of Marlborough from the command, and the impatience of the Dutch under so long and burdensome a war, led to the peace of Utrecht, to which Austria, after urgent remonstrances with her allies, and fruitless efforts in the field, acceded, by a treaty concluded the year after (1714) at Baden. Well might she give her assent to a treaty which transferred to her not only the Low Countries, but extensive possessions in both the north and south of Italy.

The emperor, anxious to confirm his authority in Hungary and Transylvania, now directed his troops against the Turks. The latter had, during more than a century, been ready to take part with the insurgents in Hungary against the Austrians, and had at one time, in 1683, advanced to the walls of Vienna, whence they were driven by a Polish army under Sobieski. This was the first serious check given to these confident barbarians. At a subsequent date Prince Eugene defeated them in several actions, and the peace concluded with them at Carlowitz, in 1699, secured to Austria a considerable accession of territory on the side of Hungary. Still that country continued divided and of doubtful allegiance to Austria. Eugene led thither, in 1716, a part of the armies with which he had conquered in Italy and the Netherlands, and applied European tactics against the Turks with distinguished success. The result was a series of splendid successes, and a treaty of peace highly favourable to Austria.

Such, however, was not the case in the last scene of the military career of Eugene, when, nearly twenty years after (in 1735), he headed the Austrian armies on the Rhine. The French had taken the field in support of the claims of Spain on the south of Italy. Austria was evidently overmatched in force; and England, guided by the pacific counsels of Walpole, declining to interfere, the result was a treaty, by which the emperor relinquished to Spain the contested territory in Italy.

In 1740 the death of the reigning emperor, Charles VI., brought to a close the male line of the house of Hapsburg, the succession devolving on Charles's daughter, Maria Theresa. The death of Charles became the signal for attack on his dominions by almost all the neighbouring powers; by Prussia, Bavaria, Saxony, and even by France. But England came forward to support the cause of Austria with a liberal subsidy, while the Hungarians, now united and loyal, recruited her armies. The aspect of affairs was soon altered; the Bavarians were driven back; and the French, who had ventured to advance as far as Bohemia, were obliged to retire to the Rhine. Frederick II. of Prussia proved a more obstinate opponent; and, as the interest of England and Holland called the Austrian forces to the Low Countries to maintain the great contest carrying on in that quarter against France, Maria Theresa was induced to subscribe, first in 1742, and afterwards in 1745, a separate treaty with Frederick, by which she ceded to him the chief part of Silesia. But the unprovoked attack of Frederick sunk deep in her mind; she watched an opportunity of revenge; and, in 1756, formed that coalition of powers against Prussia, which gave rise to a war of seven years, and to an extent of devastation such as Germany had not witnessed for more than a century. On one side was the whole Austrian force, aided by 80,000 French, and, at particular periods of the war, by the Russians and Swedes; on the other stood Prus-

Austria.

Austria. sia and England, inferior numerically to their antagonists, but managing their resources, and directing their military efforts, with all the ability belonging to the character of Frederick and Lord Chatham. On the side of the French there appeared no commander of eminence; but on that of the Austrians, Marshals Daun and Laudohn were generals worthy of being opposed to Frederick. After a number of battles and great alternations of success, both sides became tired of the waste of blood; and a contest, waged for a time with a rapidity of movement and an eagerness for conflict almost equal to those displayed in the French revolution, was marked towards its close by the cautious tactics of Turenne. At last, in 1763, a general peace was concluded, and the rival powers were left very nearly in the same position as at the beginning of the war.

From this time Germany enjoyed peace during thirty years. In 1778 the death of the elector of Bavaria gave rise to pretensions on the part of Austria, which drew once more into the field Frederick II., now grown grey in command. Austria opposed to him forces fully equal in number and scarcely inferior in discipline, but happily the campaign proved bloodless, each side anticipating a close of the dispute by negotiation. In that manner, accordingly, it ended; Austria being content with the cession by Bavaria of the frontier district, called the quarter of the Inn.

Maria Theresa had married Francis duke of Lorraine, who was afterwards elected emperor of Germany, but died in 1765. Their son, Joseph II., was then joined in the sovereign power with his mother; and, on her death in 1780, he became sole ruler. The princes of the house of Austria, disposed rather to follow than to lead, have seldom been the authors of political change; but the emperor Joseph was imbued with all the ardour of a sanguine innovator. He gave a loose to this disposition after 1780, issuing a number of edicts, of which several were praiseworthy in their objects, but abrupt and premature in their operations. He established general toleration in religion, abolished a number of monasteries and convents, dismantled various fortresses, and took steps for new-modelling the existing systems both of law and of national education. Had the public in his dominions been ripe, as in France, for a general political change, Joseph would have been hailed as a subverter of abuses, and as the author of general improvement; but the Austrians, attached to old usages, understood little of his plans, and merely received them with passive acquiescence. The actual effect was thus very limited, notwithstanding the example of new institutions in the United States of America, and soon after in France. But in Belgium the case was different: the contagion of the French revolution spread over the country, and produced a sudden rising against the Austrians. This unexpected revolt, and the chequered success of the war then carrying on against Turkey, are understood to have preyed on the sensitive mind of the emperor, and to have caused his death in 1790.

Leopold, the brother and successor of Joseph, had a very short reign, the crown devolving in 1792 on his son Francis II., the present emperor. Francis had hardly succeeded to it when he found himself involved in a contest with France, the length and vicissitudes of which proved such as to cast into the shade all former wars between that country and Austria. The first important blow was struck in November 1792 at Jemappes, where the numbers and audacity of the French obtained a signal success. Next year the superior efficiency of the Austrian armies secured to them a temporary superiority; but, in 1794, the multitudes of Frenchmen brought forward by the energetic measures of the terrorists, and the talents of commanders such as Pichegru, Moreau,

Austria. Kleber, young in years, but full of enterprise and activity, led to the conquest of the Netherlands, and to the retreat of the Austrians beyond the Rhine. France now offered to Austria a separate peace; but England engaging to furnish large subsidies, the emperor declined a treaty that would have involved the cession of Belgium. The French, determined to obtain this cession by force of arms, crossed the Rhine, in the autumn of 1795, with two formidable armies. Prussia had withdrawn from the contest, and allowed the whole weight of it to fall upon the emperor. It was then that the talents of Marshal Clairfayt, as yet known only to military men, became apparent to Europe at large. With numbers inferior to the two French armies collectively, he found means, by rapid movements, to concentrate a force superior to either singly, and drove them across the Rhine with great loss. Next year, however, the French, undismayed by failure, resumed the offensive, and crossed the Rhine again with two armies; one of which penetrated into the heart of Franconia, whilst the other overran Suabia and part of Bavaria. But these armies had not the means of affording each other ready support; they were separated by the Danube, while the Austrians were in possession of the bridges on that river, and could move within a smaller circle. They were thus enabled to repeat their manœuvre of the preceding year, by detaching a superior force against the French army in Franconia, and thus obliging it not only to evacuate the country it had overrun, but to seek safety beyond the Rhine. Such was also the case with the southern army of the French, although the retreat conducted by Moreau was the subject of general commendation.

But whilst in Germany success inclined to the side of Austria, the case was very different in Piedmont and Lombardy. In Piedmont indeed the war had long been carried on between the French and the allies without decisive success on either side. The opposing forces were nearly equal, and the mountainous nature of the country afforded so many strong positions, that there seemed no means of bringing the contest to a speedy termination. But all this was suddenly changed by the genius of one man. Buonaparte appeared on the scene, and in less than a month after receiving the command, defeated the allies in three engagements; obliged the court of Turin to make a separate peace; and, pouring his forces into Lombardy, drove the Austrians from every position in that country except Mantua. The strength of the latter place, however, bade defiance to the attacks of the French, and enabled the emperor to make repeated attempts for the recovery of Lombardy. No part of the war is more deserving of attention than this campaign; for none displayed in a more striking light the extensive resources of Austria, or the inventive mind of Buonaparte. Threatened in the end of July by an Austrian army of great strength, but which was imprudently advancing in two bodies, he hesitated not a moment in sacrificing his artillery, that by sudden marches he might assail his opponents before they effected a junction. In this he succeeded; but his loss was heavy, and the Austrians were rather repulsed than defeated. Six weeks after, a repetition by Buonaparte of these daring movements was attended with decisive success. When apparently marching against the Austrian troops in Trent, he turned suddenly to the right, and advancing by a valley, reached the head-quarters of their army before they were prepared. The result was a series of actions, which cut off the retreat of their main body, and obliged it to fly for refuge to Mantua. But ere two months had passed the Austrians prepared another army, which, advancing towards Verona, Buonaparte marched to encounter, using in his dispatch to Paris these remarkable words: *Il faut frap-*

Austria. *per l'ennemi comme la foudre, et le balayer dès son premier pas.* On this occasion, however, fortune was not favourable to him. He was worsted twice in action (on the 6th and 12th November); yet, far from being discouraged, he conceived the extraordinary plan of quitting his camp at night, and gaining the rear of that army which had twice repulsed him. He reckoned on the effect of a surprise; but his hopes were disappointed by the time unavoidably lost in attacks on the village of Arcole, which stood in his way. The main body of the Austrians had time to advance, and the result was a series of conflicts, attended with great loss on both sides.

Thus ended the campaign of 1796, sanguinary beyond example even in those days of waste of life, and not altogether conclusive in its results. Next year, however, the chances of war were no longer doubtful. The Austrians having reinforced their army, made a final effort to relieve Mantua; but Buonaparte having intercepted a dispatch with their intended plan of operations, was enabled to make such a disposition of his troops as to insure success; and the results were, the victory of Rivoli, the surrender of the force destined to relieve Mantua, and the complete expulsion of the Austrians from Italy. The French now crossed the mountain barrier, and advanced toward the heart of Austria. This, joined to the approach of their armies from the Rhine, obliged the emperor to conclude preliminaries of peace at Leoben, and afterwards a treaty proceeding on these as a basis at Campo Formio. This treaty involved the cession by Austria of Belgium and Lombardy, but gave her, in return, Venice and its dependent provinces, making an absolute loss in population of 1,500,000 souls.

This peace, however, proved only a truce. The absence of a portion of the French armies in Egypt, and the evident misgovernment of the directory, induced England to form a new coalition, and renew the continental contest early in 1799. The Austrian troops took the field, powerful equally in numbers and discipline; and the French, commanded for the first time by inferior leaders, were driven back both in Germany and Italy. The arrival of Russian auxiliaries, and the talents of Suwaroff, bore forward the tide of success, until the autumn of the year, when increased levies on the part of the French, and a better choice of generals, began to turn the scale in their favour. The capricious Paul now withdrew from the coalition, and the Austrians entered on the campaign of 1800 with their own forces only. These proved, as formerly, insufficient to withstand the French, especially when the latter were commanded in Germany by Moreau, in Italy by Buonaparte. Battles, unfortunately too decisive, took place; the victories of Hoherlinden and Marengo led to the treaty of Luneville, and to the cession by Austria of almost all her Venetian acquisitions.

This peace, though not so short as the preceding, lasted only four years. In 1805 Austria and Russia, provoked by Buonaparte's aggressions, and stimulated by English subsidies, took the field with numerous armies; but the successive overthrows at Ulm and Austerlitz rendered peace again indispensable to Austria. It was obtained (6th August 1806) by the surrender of the remainder of the Venetian territory, of the Tyrol, and of various districts, comprising a sacrifice in all of three millions of subjects. Soon after these reverses, Francis II. renounced the title and authority of emperor of Germany, and assumed the title of emperor of Austria. Taught by repeated disasters, he remained passive in the great contest in 1806 and 1807 between France, Prussia, and Russia; but in 1809 the war in Spain having withdrawn a very large portion of the French force, he ventured once more to try his fortune in the field. The Austrian armies were numerous; but Buonaparte had still

a powerful French force at command, and was aided by all the troops of the confederation of the Rhine. The Austrians, worsted in Bavaria, retreated to Vienna; and although temporary hopes were excited by their success at Aspern (21st and 22d May), they were blasted by the disastrous day of Wagram, and peace was again purchased by a sacrifice of territory containing more than three millions of inhabitants. Austria, now reduced to a population of twenty millions, remained in peace during the years 1810, 1811, and 1812; but when the disasters of the French in Russia once more raised the hopes of Germany, and brought friendly standards into Saxony, Austria took part with the grand alliance, and her troops bore a conspicuous part in the battle of Leipsic and the invasion of France. The definitive treaties of 1814 and 1815 reinstated her in all her former territories, except Belgium, and gave her substantial additions on the side of Italy. Satisfied with these, the Austrian government has ever since wisely abstained from war, directing its attention to the reinstatement of its finances, and the promotion of its productive industry.

Population of the Austrian Empire in 1831; the provinces classed by the comparative density of the inhabitants. Present divisions and population.

	Population of the Province.	Inhabitants per Square Mile.
Tyrol.....	780,000.....	50
Dalmatia.....	340,000.....	58
Military frontier adjoining Turkey.....	1,000,000.....	73
Slavonia.....	370,000.....	85
Transylvania.....	2,000,000.....	88
Hungary.....	9,000,000.....	100
Styria.....	850,000.....	102
Governments of Laybach and Trieste (Carinthia and Istria).....	1,160,000.....	105
Croatia.....	600,000.....	110
Upper Austria and Salzburg... ..	900,000.....	130
Galicia of the Buckowine.....	4,400,000.....	135
Lower Austria, including Vienna.....	1,300,000.....	165
Moravia and Austrian Silesia.....	2,000,000.....	185
Bohemia.....	3,900,000.....	190
Lombardy and the Venetian provinces.....	4,400,000.....	245
Population of the empire.....	33,000,000	
Yearly increase, computed from the last 10 years....	400,000	
Average of the whole empire per square mile, nearly.....		130

Such are the constituent portions of this great empire. Differing as they do in climate, soil, language, and customs, no general description can possibly apply to the whole. We shall therefore recapitulate the chief characteristics of each in succession, classing them in the following order: The archduchy of Austria; Hungary and the adjacent provinces; Bohemia, Moravia, Galicia; the Alpine Provinces; Lombardy and Venice.

AUSTRIA, THE ARCHDUCHY.

The archduchy of Austria consists of two nearly equal parts, viz. Upper and Lower Austria. The river Ens, flowing northward from the Alps to the Danube, intersects the archducal territory nearly in the middle; the country to the east of the river being Lower, and that to

Austria. the west Upper Austria. Lower Austria, in particular the fertile tract adjoining the Danube above and below Vienna, formed originally the *nucleus* of that union of states which now constitute the second empire in Europe. That district is both the site of the capital and the seat of extensive manufactures. These consist principally of woollens, cottons, and hardware, the yearly value of which, added to the lesser fabrics of hardware, leather, glass, hats, and paper, is computed at three or four millions sterling. In the mountainous part of the province are mines of iron, coal, and rock salt; but the wealth derived from these is slight compared with that resulting from the agricultural products of the more level part of the country. These consist of wheat, barley, oats, and other corns raised in England; and, in the warmer situations, of maize and vines. Advantage is taken here, as in Lombardy, of the numerous streams which flow from the mountains in the south towards the Danube. They are used for irrigation, the great *desideratum* of the agriculturist in a warm situation. Besides, the produce of the land along the Danube, from Vienna to the Bavarian frontier, has been greatly increased within the last half century, by the use of marl. The traveller, in pursuing this track, sees in all directions a quantity of marl pits, wrought with great activity; but still the crops raised are much smaller than they would be under a system like that of our improved countries.

Upper Austria, or the country west of the Ens, was added to the sister province in the twelfth century: it is called Upper, from its comparative vicinity to the Alps, and its greater elevation of surface. Its wealth consists not in manufactures, but in agricultural produce. It is too cold for the culture of the vine; but the low grounds are productive in corn, while the pasturages are extensive both in the hills and the valleys. The sides of the mountains are covered with forests, the timber of which finds to a certain extent an outlet by navigable rivers, of which the chief are the Ens, the Salzach, the Traun, and the Trasen. One of the principal sources of employment to the lower orders in the forest-lands consists in felling their timber and conveying it to these rivers, whence it is floated to the towns along their banks, or to the Danube, the great channel for the transport of bulky commodities. Upper Austria, since the acquisition of Salzburg, has an extent (about 7500 square miles) nearly equal to that of Lower Austria; but in population it is far inferior, containing only 900,000 inhabitants, while the lower province reckons 1,300,000.

Population of the Chief Towns.

Lower Austria.	Upper Austria.
Vienna.....300,000	Lintz.....20,000
Neustadt.....8,000	Salzburg.....11,000
Krems.....5,000	Steyer.....9,000

The early inhabitants of Austria are understood to have come partly from among the Germans in the west, partly from the Slavonian tribes in the north and east. German is now almost the sole language of the inhabitants, but it differs considerably from the German spoken in Saxony. As to religion, almost all the inhabitants are Catholics. Situated to the south-east of Germany, and comparatively backward in civilization, Austria was long considered as rather an outwork than an integral part of the empire; it was not until 1438 that the election to the imperial crown fell almost invariably on the head of the house of Hapsburg. The power of the sovereign in the archduchy is almost unlimited, but it is exercised with mildness, and with the concurrence of a parliament or states, composed, as in the other great divisions of the monarchy, of prelates, noblemen, and the deputies from the barons and principal towns.

HUNGARY,

Austria.

The most extensive of the great divisions of the Austrian empire, is of an oblong or rather heptagonal form: its length is 370 miles, its general breadth above 300, and its superficial extent, nearly 9000 square miles, is equal to that of Great Britain. For the purposes of administration, Hungary is divided into four circles or provinces, called respectively the circle north of the Danube, the circle south of the Danube, the circle west of the Theiss, and the circle east of the Theiss.

The latitude of Hungary is between 45° and 49° north. The degree of elevation of the surface is very different in different parts; the Carpathian range extending over a great part of the west and north of the kingdom, while the central and south-east divisions consist of a succession of plains. The climate is marked by equal differences, the mountainous districts being cold, while the plains are warm, and, in the summer months, much hotter than in England. The products of the higher grounds are oats, barley, rye; of the lower, wheat, maize; and in the rich alluvial soil adjoining the rivers, rice. But tillage is as yet extremely backward in Hungary, the improvements so familiar to our agriculturists, such as draining, irrigating, and even inclosing, being here almost unknown; while iron being high priced for the means of the farmers, their implements are wretched, and their ploughs do little more than scratch or move the surface of the ground. The poverty of the peasantry in most parts of Hungary is such, that to pay their rent in money is out of the question: they accordingly discharge it partly in produce, partly in personal service.

The climate of Hungary being sufficiently warm for the vine, its cultivation is carried on extensively, though with much less skill than in France. Hemp, flax, and tobacco, are also raised in considerable quantities. Though artificial grasses are unknown in this country, the natural pastures are good; and horses from Hungary form, as is well known to military men, a large proportion of the Austrian light cavalry,—though small of size, they are swift and active. As to horned cattle, this is perhaps the only country in Europe that can vie with England. The oxen are large and well shaped, and roam over the pasture districts in vast herds: but they are exposed with little or no shelter to the cold of winter and to the heat of summer; and hence at certain seasons there have occurred among them diseases attended with great mortality. The sheep in like manner pass almost the whole year in the open air; and the shepherds may be said to share in this exposure, having no habitations that deserve the name. The quality of the wool, though greatly inferior to that of Saxony, has received improvement in the course of the present age.

Appropriation of the land in Hungary, Slavonia, and Croatia, exhibited in proportions of 100:—

Under tillage.....	12
Vines, orchards, gardens.....	4
In pasture, chiefly natural.....	17
Forest land.....	19
Marshes, high mountains, sandy plains, and other as yet uncultivated tracts.....	48

100

This shows but too plainly how great a proportion of Hungary and the adjacent provinces is still in a neglected and half-cultivated state. In some parts the extent of sandy plain is so great as to remind the traveller of an African desert, and to fatigue the eye by an horizon without a boundary. The extent of marsh land in Hungary is computed at 3000 English square miles; but there are also large tracts along the banks of rivers lost to cultiva-

Austria. tion, from occasional inundations caused by heavy rains or the melting of snow in the Alps and Carpathians.

The chief towns of Hungary are as follows :—

In the western half of the kingdom.	Population.	In the eastern or more remote part of the kingdom.	Population.
Pesth.....	40,000	Debretzin.....	42,000
Ofen or Buda, the present capital..	30,000	Erlau.....	17,000
Presburg, formerly the capital.....	35,000	Gross Wardein.....	15,000
Zombor.....	18,000	Miskoloz.....	14,000
Raab.....	14,000	Kaschau.....	12,500
Stuhl Weissenburg.....	13,000	Temesvar.....	12,000
Edenburg.....	13,000	Bekess.....	11,000
Kremnitz.....	10,000	Szathmar.....	11,000

Such are the only towns containing 10,000 inhabitants or upwards, in a population of nearly nine millions. Four-fifths of the inhabitants of Hungary are scattered over the country in huts; and in fact the towns, with the exception of the three which stand first on the list, are little more than collections of cottages. In a country so deficient in town population, and so backward in other respects, manufactures are necessarily in a rude state. They are limited to coarse woollens, coarse linen, and other articles woven in the cottage of the manufacturer, in the homely manner of our ancestors two centuries ago. Tobacco is raised and manufactured here in large quantities, but it is consumed in the country. There are mines of iron, copper, lead, gold, and silver, but all of limited extent. The foreign trade of Hungary is confined to an annual import of manufactured goods, and an export of wool, hides, and other raw materials. The Danube traverses almost the whole kingdom from west to east, as does the Theiss from north to south; and the depth of both is such as to admit the ready passage of vessels down their streams, but the navigation upwards will be difficult until aided by steam or mechanical power. The chief intercourse in Hungary, whether for produce or merchandise, is consequently carried on by land; and Debretzin owes its comparatively large population (42,000) to its position on one of the very few high roads in this country, where it is a central station for traffic between Transylvania in the east and Hungary in the west.

The name of Hungary (in German *Ungarn*) is said to be derived, not from the Huns, who entered this country in such numbers under Attila in the fifth century, but from the word Unger, "new comer," applied by the natives to invaders of later date. Be that as it may, the population of Hungary is of a very mixed character, whether we consider their origin, religion, or language. As to religion, the computation is, that the Catholics amount to 5,000,000, the Protestants to above 2,000,000, the Greek church to 1,800,000, and the Jews to 160,000. Germans, or descendants of Germans, reside in most of the larger towns; and whatever can be termed improved husbandry has been introduced from their country, from Austria, Bavaria, and Suabia. The Germans are found chiefly in the west of Hungary, the part nearest to the empire, but they bear a small proportion to the rest of the population. At the head of the latter are the Magyars or Madjars, the descendants of a tribe from the east of the Wolga, who settled in Hungary under a leader of the name of Arpad in the ninth century. They are a comely and spirited race, who prefer agriculture and the tending of cattle to mechanical employments. The *aborigines* were doubtless of the Slavonian race, and their descendants consist at the present day of various tribes, viz. the Slowacs, the Rascians or Servians, the Reusniacs (from Red Russia), and the Wallachians. The most numerous of these different tribes are the Slowacs. The languages spoken in Hungary are almost as varied as

Austria. the descent of the inhabitants. The Magyar is properly the Hungarian language, and is spoken currently by all who bear the name of Magyar; but as it is wholly different from German, Latin, which is generally understood, and even spoken by the upper classes, is made the vehicle, not only of official business, but of newspapers, or whatever is intended for general circulation.

The political connection between Hungary and Austria goes back nearly four centuries, the crown having devolved to the Austrian family in 1437, and having been vested ever since 1527 in the head of that house. A very long time, however, elapsed before the Austrian government became popular in Hungary. On the one side despotic habits and intolerance in religion, on the other the restless spirit of the great barons, were the cause of repeated insurrections, and of coalitions with the Turks, which twice (in 1529 and 1683) brought an Ottoman army to the walls of Vienna. Montecuculi, Sobieski, and Prince Eugene, successively routed these undisciplined hosts; but it was not until the early part of last century (in 1718), when the final victories of Prince Eugene drove the Turks out of Hungary, and the court of Vienna adopted a conciliating course, that the Hungarians, as a nation, became impressed with that attachment to their Austrian sovereigns which has ever since been eminently their characteristic.

In no country is the line more strongly drawn between the upper and the lower classes. The former have an exclusive right to public appointments; and a grant of land by the sovereign to a plebeian must be accompanied by a patent of rank, the right of possessing land in Hungary being confined to the higher classes. They are exempt also from all direct imposts; tithes, toll-dues, and a tax called the thirtieth penny, being all assessed on the peasantry and the inhabitants of towns. The duty of the nobility and gentry in Hungary is of a higher order; it is to serve personally under their sovereign, taking up arms whenever a war has received the approbation of the diet. The emperor Joseph II. was inclined to put his Hungarian subjects on a more equal footing; but he found, on the one hand, that the lower classes were not ripe for the advancement he intended them, and on the other, that what seemed their greatest grievance (an undue share of taxation) was more nominal than real, the peasantry obtaining in their rents, and the inhabitants of towns in the enhanced price of articles, an indemnity for their greater share of the public burdens.

The regular or standing army in Hungary in time of peace is about 50,000 men; in war that number is readily doubled, at the call of the crown, by an extraordinary levy called *insurrectio*. In the frontier line extending along the Turkish territory, military service is accepted from the inhabitants in lieu of tithe and taxes, so that there is a strong permanent militia in that quarter. The public revenue of Hungary is between L.3,000,000 and L.4,000,000 sterling. It is derived partly from the *regalia* or rights of the crown, such as the crown-lands, the monopoly of salt, the mines, and assessments on the church lands; partly from taxes voted by the diet, such as a land-tax, a poll-tax, and an impost on cattle. The diet or parliament consists here, as in Bohemia, of four "states" or classes; the Catholic prelates, the magnates or peers, the representatives of the *inclyti* or landholders, and the deputies from towns. The two first mentioned form the upper, the two last the lower house. The president of the former is the prince palatine, and in his absence the noble of highest rank: in the lower house the imperial, or, as he is here termed, the royal commissioner, is president. The deliberations generally proceed in separate chambers; but in case of non-agreement, the two are

Austria. united in one, and questions are decided by a majority of votes. No serious division, however, has for a long time taken place either in the diet or between the diet and the executive government. The power of the sovereign in Hungary, though not so great as in Bohemia or the hereditary states, is very considerable, comprising not only the executive administration, but the proposition of all bills to the diet, and the patronage of the Catholic church. A council of state at Buda, and a higher council at Vienna, constitute what may be termed the cabinets for the affairs of Hungary.

Transylvania. The principality of Transylvania is very extensive, having a territory of considerably more than 20,000 square miles, with a population of nearly two millions. It is situated to the east of Hungary, and its name was given to it on account of the vast forests which separate it from that kingdom. Its surface is very diversified, consisting of alternate mountains and valleys. In so wide a tract of country there is necessarily a number of plains; but few of them are of great extent. The changes of temperature consequent on change of wind are frequent, and, at times, great in degree. The soil, though not deficient in natural fertility, has as yet been little cultivated: the chief products are maize and vines in warm situations; wheat, oats, and barley, on the higher grounds. The forests have long been, and still are, very extensive. There are here a number of mines of the precious metals, which, though less profitable than is commonly supposed, give employment to many thousands of the lower class. The manufactures are generally in a rude state, and can hardly be otherwise so long as the country remains destitute of conveyance by water, or of good roads. The inhabitants are chiefly of Slavonian descent, and with as many varieties as in Hungary, each tribe adhering to its peculiar customs, though settled in the immediate vicinity of other tribes. The prevailing religion of the Transylvanians is that of the Greek church: it is professed by nearly three fourths of the population, while the Protestants amount to 400,000, and the Catholics to only half the number. To one or other of these belong the descendants of Germans who settled in this country, and who are in number about 400,000. The constitution of Transylvania is nearly the same as in Hungary, the diet or representative body being on a similar footing. The languages spoken here are as various as in Hungary; Latin being used for public papers and communications of importance, the Magyar for personal intercourse. The public revenue is about 500,000 a year.

Croatia. Croatia, an extensive province to the south-west of Hungary, is marked by physical features similar to those of Upper Austria or Carinthia, being pervaded by mountains in almost every direction. The climate consequently differs according to the elevation of the soil, the degree of cold being in many parts nearly as great as on the Carpathian Mountains; while the tract along the coast of the Adriatic has a comparatively mild climate, as also the plains in the interior. In the latter are raised maize, vines, and the fruits common in the south of Europe. The forests of Croatia are of great extent, consisting of oak, elm, ash, beech, and, in the higher grounds, of fir and pines. The mines, though naturally productive, are as yet very imperfectly wrought, not excepting those of iron. The extent of this province is between 5000 and 6000 square miles. The inhabitants, in number about 600,000, are almost all Catholics: the majority are of Slavonian descent, and speak the language of their ancestors. The Germans are comparatively few, and are the descendants of those who from time to time settled in this uncivilized quarter to exercise mechanical employments, with which the natives were unacquainted.

Slavonia, situated to the east of Croatia, is somewhat less extensive, having a surface of about 5000 square miles, with a population of 370,000. The figure of this province is long and narrow; its northern frontier, formed by the Drave and Danube, separating it from Hungary, while the Save, also a large river, divides it on the south from the Turkish territory. From its position under the 45th and 46th degrees of north latitude, its climate would be warm throughout, were it not traversed throughout its whole length by a chain of lofty mountains, covered with forests. The consequence is, that the low grounds alone have a sufficient degree of temperature for the cultivation of maize and the fruits of the south of Europe. The higher districts produce wheat, barley, flax, hemp, and madder. The rivers and streams flowing from the hills often inundate the low country, and leave, as in Hungary, a quantity of stagnant water, the effect of which is very injurious to health. The dwellings of the peasantry are in general mere mud huts; but in the forest tracts they are log-houses covered with slate. This extreme poverty of Slavonia is to be ascribed to its having been long the seat of war between the Turks and Hungarians; for it was not till the year 1700 that it came definitively into the possession of Austria. The majority of the inhabitants are consequently of the Greek church; the Germans settled here being, as in Croatia, comparatively few.

The Military Frontiers form a long and narrow tract of country, extending several hundred miles, from the Carpathians in the east to the Adriatic in the west, along the confines of Transylvania, Hungary, Slavonia, and Croatia. The climate, the state of agriculture, and the degree of civilization, are similar to those of the adjoining provinces. After the year 1718, when the successes of Prince Eugene had obliged the Turks to cede this country to Austria, a constitution adapted to a frontier district was framed for it, and has continued in force ever since. Its fundamental principle is to enable the inhabitants to defend themselves by being accustomed to the use of arms, and by giving personal service in the field in lieu of taxes and the rent of land. Every man along this extensive line may be said to be born a soldier; at least in every family one of the males is bound to do military duty, and all are liable to serve when called on. In return they are exempted from tithe and all direct taxes. They have also assigned to them portions of land, which descend from father to son. Even civil affairs in this country are conducted in a military form; the different magistrates bearing the rank respectively of generals, colonels, and captains. The population of this extensive line of country is nearly 1,000,000, the efficient force about 50,000 militia.

BOHEMIA.

Bohemia, which ranks immediately after Hungary among the great members of the Austrian union, bears the title of kingdom, and is amply entitled to it by its extent, its population, and its progressive improvement. Backward as it still is, its resources, as the imperial government is well aware, are of a nature very different from those afforded by the mountainous provinces of the Alps, or the half-civilized districts on the side of Turkey. It is situated between the 48th and 51st degrees of north latitude; its form is an irregular square; its area, not yet accurately ascertained, is computed at fully 20,000 square miles, or three fourths of the extent of Scotland. It is separated from the surrounding countries by ranges of mountains which encircle it on every side. From this, and from the general appearance of the interior, there seems little doubt that in an early age the chief part of Bohemia was covered with water, and that such conti-

Austria. *nued the case until an outlet was opened at the northern and least elevated part of the chain, in the direction by which the Elbe still flows, carrying with it the waters of tributary streams from almost every part of the kingdom.*

This separation from the adjacent countries, particularly from the comparatively improved states of Saxony on the north and Franconia on the west, necessarily operated to the disadvantage of Bohemia, and retarded its advance in civilization. German settlers resorted to it from time to time, but individually or in small parties, never in numerous bodies, or in a manner that enabled them to disseminate extensively the improvements of their respective countries.

History. Of the aboriginal inhabitants of Bohemia there are no distinct accounts; but the name of the country confirms the current tradition that they were the Boii, a well-known Celtic tribe. Christianity appears to have been introduced among them only towards the close of the ninth century, the era of the commencement of their historical records. The ruler or governor then bore the name of grand duke, and the succession under that, as under the subsequent title of king, was for a long time elective. In the thirteenth century Ottocar I., a prince of ability, passed laws similar to those which were enacted in England about the same time by Edward I., exempting the inhabitants of villages from dependence on the neighbouring barons, and enabling them to possess their little properties in security. His son and successor, Ottocar II., followed a similar course; a system of laws was compiled and reduced to writing in German; and Prague, the capital, became a town of importance. Bohemia was, as is well known, the country of John Huss and Jerome of Prague, who exposed the fallacies of the church of Rome, but at too early a date; for the public, not then enlightened by the art of printing and the circulation of sound doctrines, misunderstood their views; a civil war burst out, and the result tended to perpetuate the abuses which these well-meaning men had laboured to remove.

The crown of Bohemia, like that of Hungary, had at different intervals been held from marriage connection by princes of the house of Austria; but in 1526 both crowns devolved on the head of that house, and have ever since been held by it in hereditary succession.

Climate and soil.

The climate of Bohemia varies greatly, according to the elevation of the ground; the plains and valleys being warm, while the mountains in the south, as in the north, are cold and bleak. The annual fall of rain differs in like manner according to situation; but 20 inches a year is said to be a frequent average. The soil of Bohemia is in general good, but the agriculture extremely backward. The chief products, as in a similar latitude in England, are wheat, barley, rye, oats, potatoes; also hemp, flax, and hops. In some warm situations vines are cultivated, but as yet on a small scale. The pastures, on the other hand, are extensive, and in many parts as good as those of Saxony and Silesia; but the inhabitants are far behind their neighbours in the management of their flocks and the quality of their wool. In the rearing and training of horses the case is otherwise: considerable improvement has been made in both, studs having been established in different parts of the country by the Austrian government, which draws a large proportion of its cavalry from this quarter.

Forests, rivers.

The forests of Bohemia are of great extent; and large quantities of timber are annually cut down and shipped in the parts adjoining a navigable river. The Elbe and Moldau are of great use for the conveyance of these as well as of other bulky commodities. The Elbe rises in the east of the kingdom; but the Moldau, which at their junction is the larger river, rises in the southern extremity of

Austria. Bohemia, and has a course of above 150 miles, nearly the whole width of the kingdom. The Eger, the river next in size, rises in the west, and has a course of about 100 miles, with a less rapid current than the Moldau.

Bohemia is divided into sixteen circles or counties, varying, of course, in extent and population, but containing on an average nearly 1300 square miles, and 250,000 inhabitants.

Population of the Chief Towns.

Prague.....	90,000	Pilsen.....	8,000
Eger.....	10,000	Budweis.....	7,000
Reichenberg.....	10,000	Konig-gratz.....	6,000

Besides these there are about fifteen petty places with 2000, 3000, or 4000 inhabitants each; but altogether the town population, with the exception of the capital, is insignificant. That of the country is very different: it approaches in density to that of Ireland; the farms being small, and the cultivation being carried on almost wholly by manual labour.

The manufactures of Bohemia have made considerable progress in the last and present age: they consist chiefly of woollens, linen, and leather, but they comprise also cottons, hardware, and glass. The value of these different fabrics approaches to an annual total of three millions sterling, a large amount for so poor a country. Great part of the woollen and linen is woven, as in the last age in England, in cottages. The mountains contain ores of iron, lead, tin, cobalt, and silver; but iron alone is extracted on a large scale. The foreign trade of Bohemia with Saxony and the north of Germany is carried on by the Elbe, but with most other parts by land-carriage. The communication now making, partly by canal, partly by railway, from the Moldau to the Danube, will be of great advantage to Bohemia, as will a farther extension of the turnpike roads, which at present hardly exceed 1000 miles in total length, or one twentieth of the roads of England; and nowhere are good roads more wanted than in Bohemia, for business there is still carried on, in a great measure, by itinerant dealers, who pass the summer in conveying their goods to public fairs held periodically at the different towns.

The population of Bohemia has greatly increased in the last and present age. In 1791 it was considerably below 3,000,000. At present it amounts to 3,900,000, and bids fair to rise soon to 4,000,000. Of these about a third part are of German extraction, the other two thirds being descended from the aboriginal stock. The ancestors of the Germans settled here from time to time, as mechanics, miners, and traders; employments which the uninstructed natives, like the cottagers of Ireland, were not capable of exercising. At present, even, it is by the German part of the population that whatever relates to public business or to foreign trade is conducted; the Bohemians generally confining themselves to husbandry in the country, or to common labour in towns. The middle classes, in general, speak both German and Bohemian; but the latter, which is quite different from German, is the only language of the lower orders, particularly in remote districts. The power of the sovereigns is as great in Bohemia as in any part of the Austrian dominions. The parliament or states consist of four classes of members; the clergy, the great nobility, the nobility of the second class, and the representatives of the chief towns. But their duties are little more than nominal. They deliberate on the measures proposed to them by the royal commissioner, but they have no power to originate a bill. As to public revenue, Bohemia contributes fully two millions to the imperial treasury, and maintains a force in regulars and militia of 50,000 men.

Austria. Moravia, and Austrian Silesia, which is now annexed to it, contain an area of 11,000 square miles, with a population of 2,000,000, a degree of density approaching to that of England, and nearly double the average population of Germany. This is owing chiefly to the fertility of the soil; for although chains of mountains cross the country in several directions, the plains and valleys are extensive, yielding in abundance wheat, rye, oats, barley, and, in the warmer situations, vines. The pastures also are good, and a number of horses and horned cattle are exported annually. Here, as in Bohemia, the majority of the inhabitants are of Slavonian descent; and the language of the lower orders is not German, but a dialect of the Slavonic. Moravia resembles Bohemia in other respects,—in the religion of its inhabitants, who are chiefly Catholics; and in the limited power of its states or parliament, who deliberate on such subjects only as are proposed to them by the executive government. But it surpasses Bohemia, and every part of the Austrian dominions, except the Vienna district, in its extent of manufactures and the use of machinery. Woollens, linen, and, since the beginning of the present century, cottons, are here made in large quantities, both for home consumption and export.

Austrian Silesia has an area of 1900 square miles, with a population of 400,000. It consists of two circles or counties, called, from their respective chief towns, Tropaup and Teschen; but, for the administration of justice and other public purposes, Austrian Silesia is considered as united with Moravia. It resembles that country, too, in the activity of its productive industry. The density of its population is owing less to an advanced state of tillage than to extensive manufactures of linen and woollens. The pastures of this country are in general rich, and the export of wool, already considerable, is likely to increase.

Galicia. Galicia bears the title of kingdom, to which it is well entitled; for its territory, above 32,000 square miles, is greater than that of Scotland, and its population, distinct from that of the Buckowine, exceeds 4,000,000. It is of an oblong form, and is divided for purposes of government into two parts, called respectively East and West Galicia. The name of Lodomeria (in Polish Wlodomir) is now obsolete, or used only in diplomatic papers. The whole belonged formerly to Poland; and in its physical aspect Galicia greatly resembles that country, consisting of a succession of plains, with few elevations except in the south, where it is intersected by a part of the Carpathian range. The climate is consequently temperate, and even warm. The chief products are, as in a similar latitude in England, wheat, oats, rye, and barley. The summer heats being much greater than in this country, the culture of the vine is practicable in certain situations, but has not yet been carried to any considerable length. The pastures, on the other hand, are extensive, and supply the Austrian cavalry with a number of good horses. Farming, however, is as backward here as in the rest of Poland, or in the least improved parts of Germany. The peasantry, till lately in a state of servitude, have still the indolent habits of vassals, and must often be driven to their labour by compulsion. The roads in Galicia are in general very bad, and the extent of river navigation is very limited; but the level surface of the country is favourable to the forming of both roads and canals; and were Galicia less distant from the sea, its exports, particularly of corn, would soon become considerable. German is the language for public documents and official business, but Polish is spoken by the people at large. In like manner, as to religion, the Roman Catholic is the established faith; but the majority of the inhabitants, being of Slavonian descent, are of the Greek church. Here, as in the rest of Poland, the dealers and traffickers are

Austria. almost all Jews, whose total number approaches to half a million. Of the backwardness of this country in manufactures and the mechanical arts we may judge by the smallness of the town population; Lemberg, the capital, being the only place which as yet sends deputies to the Galician diet. The members of that assembly consist wholly of prelates and landholders.

Extensive as the portion of Galicia subject to Austria is at present, it was formerly still larger. Russia having taken part against Austria in the disastrous campaign of 1809, the latter power was obliged by Buonaparte to cede to Russia the eastern part of Galicia. Nor was this valuable territory restored in the general adjustment of 1815, because the principle of that adjustment was, that Russia should be indemnified in Poland, as Austria was in Italy, and Prussia on the banks of the Rhine.

The Buckowine is an extensive district, formerly part of Moldavia, but ceded by the Turks to Austria in 1777. It now forms a circle or county of Galicia, having an area of 3700 square miles, and a population of 260,000. The western part adjoining the Carpathian Mountains is high and barren; but the rest of the country is in general fertile. The forests of oak are here of great extent, and seem to have given name to the country, *buckow* in Slavonian signifying an oak.

THE ALPINE PROVINCES.

The duchy of Styria, one of the earliest acquisitions of the Austrian family, has an extent of nearly 9000 square miles, with a population of 850,000, of whom more than half are of German descent, while the remainder are Wends or Slavonians. The inhabitants differ in language, but are agreed in religion, being almost all Catholics. Styria bears a resemblance to the adjoining province of Carinthia, both in soil and climate; Upper Styria being very mountainous, while in Lower Styria the ground has less elevation as it recedes from the Alps. Hence a corresponding difference in temperature and products; the mountainous part being covered with forests, and fit only for pasture, while the plains and valleys produce wheat, barley, oats, rye, and, in the warmer situations, maize. The culture of potatoes, though introduced less than a century ago, has now become general, and has been the means of adding largely to the population. The mines are extensive, particularly those of coal and iron; the steel of Styria is as noted in Germany as the Swedish steel in the north of Europe. Salt also is obtained here in great abundance.

Tyrol bears in official papers no higher name than that of county (in German *Graf-schaft*); but it is by far the largest county in Europe, having an extent of above 15,000 square miles, with a population of 780,000. It is traversed in every direction by mountains, many of them of great height; while the low grounds consist, not of plains of any extent, but of a succession of long valleys to the number of more than twenty. In these the climate is comparatively warm, and the soil in many parts fertile, producing corn in considerable quantity, and, in favourable situations, vines. The ploughs and agricultural implements used in this country are extremely rude; but the inhabitants show both ingenuity and industry in cultivating slopes and summits, wherever there is enough of soil to reward their labour. In this mountainous region waterfalls are frequent, and many of them are made available to the movement of mills and other machinery. Mineral ores are found in Tyrol to an extent that justifies the expectation that they may be made to afford eventually considerable employment and income to the inhabitants; but in a country so rugged in its surface, and so

Austria. deficient in machinery, little progress has as yet been made in working mines. Manufactures are equally backward; the work required for them, whether spinning, knitting, or weaving, being almost all performed by the hand.

The domestic animals in Tyrol are, in general, of a diminutive size. The forests contain wolves, bears, goats, and many other animals in a wild state; hence the number of *chasseurs* or sportsmen in Tyrol, and their dexterity as sharpshooters, so frequently evinced in the late wars. The Tyrolese, though of a warlike character, and strongly attached to the house of Austria, dislike the restraints of discipline. They perform, however, militia duty, and are called out for training during several weeks in the year.

The language of the Tyrol is German. Like the other provinces of the Austrian empire, it has its states or parliament, composed of deputies from the clergy and nobility, to whom there have been added, for some time past, deputies from the peasantry.

Carinthia. Carinthia adjoins Tyrol, and, like it, consists of a succession of mountains separated by narrow valleys. It contains a number of lakes, formed, as in the highlands of Scotland and other mountainous countries, by water collecting in hollows, and finding no outlet, except at a considerable height. Tillage is here on a very limited scale; but the pastures are more extensive, and the forests which cover the sides of the mountains would be very valuable, were it practicable to convey the trees to a navigable river. The mines of this province are extensive, particularly those of iron, lead, and quicksilver. The extent of Carinthia is 4000 square miles; its population 300,000. The chief towns are Clagenfurth and Villach.

Carniola. Carniola, the adjacent province, is more populous than Carinthia; because, though mountainous in the north, it has in the south extensive valleys and fertile plains. Here are also a number of mines of iron, lead, and quicksilver. The agricultural products are not merely wheat, rye, and barley, as in Carinthia, but maize and vines, the sure indication of a warmer sun. Of a population of half a million, only a tenth part are of German descent; the rest are Slavonians. Carinthia, Carniola, Istria, and part of Friuli, form the present kingdom of Illyria, which is divided, for purposes of administration, into two great districts or governments, Laybach and Trieste.

Dalmatia. Dalmatia, though dignified with the title of kingdom, is a long, narrow, and, as yet, thinly peopled tract, extending along the east shore of the Adriatic, from lat. 42. to 45. It comprises the whole of what was formerly Venetian Dalmatia, along with the smaller territories of Ragusa and Cattaro. Its extent is about 6000 square miles; its population 340,000. Its agricultural products, maize, vines, olives, and silk, give proof of a climate considerably warmer than in any of the above-mentioned provinces. Here, as in those provinces, the ranges of mountains are extensive; but there are also beautiful and fertile valleys. The iron mines and the marble quarries of Dalmatia are both of great extent; but as yet they are little wrought, on account chiefly of the thinness of the population. Such parts of the forests as adjoin navigable rivers, or have ready means of conveyance to the coast, are made available for ship-building; the Austrian government adopting the views of Buonaparte in considering Dalmatia of great importance towards forming a navy. No part of Europe abounds more with good harbours than the mainland of Dalmatia, and the numerous islands along the coast.

AUSTRIAN ITALY.

Austrian Italy. We now enter on a very different scene; for nothing can exhibit a stronger contrast than the portion of Italy subject to Austria, and the mountainous provinces which

separate it from the rest of the empire. In treaties and other public acts, this country is styled the Lombardo-Venetian kingdom, from its two great divisions, situated respectively to the east and west of the river Mincio, which, flowing from north to south, divides the country into two nearly equal parts. Lombardy, or the western province, is called the government of Milan; while the province to the east of the Mincio is the government of Venice. Each government is further divided into delegations, each of the extent of our middle-sized counties, as follows:

Government of Milan.		Government of Venice.	
Delegations.	Population of the Chief Towns.	Delegations.	Population of the Chief Towns.
Milan.....	160,000	Venice.....	115,000
Pavia.....	20,000	Verona.....	55,000
Lodi.....	14,000	Rovigo.....	7,000
Bergamo.....	28,000	Padua.....	48,000
Brescia.....	32,000	Vicenza.....	30,000
Cremona.....	26,000	Belluno.....	8,000
Mantua.....	23,000	Treviso.....	15,000
Sondrio.....	3,500	Udina.....	18,000
Cômo.....	8,000		

The amount of town population exhibited in this list is far beyond that of any other portion of the Austrian empire; and the same holds in regard to the agriculture and manufactures of this interesting country. Its extent is 18,000 square miles, about two thirds of that of Ireland, and it is level almost throughout; its large and beautiful plains extending with little interruption from the Ticino or Tesin on the western frontier, to Venice on the east, a distance of 200 miles. The soil, naturally rich, is so much improved by centuries of cultivation, that it has been frequently called the garden of Europe. The warmth of the climate makes irrigation the chief *desideratum* with the husbandman, and his labours for that purpose are greatly facilitated by the number of rivers and streams flowing from the Alps across extensive plains to the Po. Wheat, maize, rice, and vines, are the principal products, to which are to be added silk, flax, and hemp. The pastures also are rich and extensive. The chief exports are corn, cattle, silk, wool, and fruits.

The population of Austrian Italy is nearly four and a half millions. It was under the control of France during eighteen years, from 1796 to 1814. It was then re-occupied by the Austrians, and erected into a kingdom, which, though declared to be inseparable from the Austrian crown, has a constitution of its own, with a prince of the imperial family at its head having the title of viceroy. Its revenue is larger in proportion to its extent than that of any other part of the empire except Vienna and its district. Venice is the city of the north of Italy which has the least partaken of prosperity in the present age; a natural consequence of its loss of sovereignty in 1797. But it is now declared a free port by the Austrian government; and the inhabitants have hopes of recovering, in some degree, the commercial activity of former ages.

After this description of particular portions of the empire, we shall proceed to state what is common to the whole under the following heads:—Physical Aspect, Soil, and Climate; Products, Manufactures, and Trade; National Income; Military Establishment; Religion, Education, and National Character; Government and Laws; Foreign Politics.

Physical Aspect, Soil, and Climate.

Of the rivers in the Austrian territory, by far the most interesting is the Danube. Before entering the imperial

Austria. dominions, it receives a number of rivers flowing northward from the Alps, of which the principal are the Inn, the Iser, the Iller, and the Leck. It next receives the Ens, and flows eastward with a full stream, varying in breadth from a quarter to half a mile. It is bordered throughout this part of its course by high grounds or ridges of mountains, the distance of which from the water is generally greater on the south than on the north side. It is of sufficient depth to bear barges and large boats throughout the whole Austrian territory, and in Hungary it admits vessels of considerable size. Its navigation, however, is not easy, its banks being in various parts steep and rocky; while in the level countries, in which its waters are more widely spread, its bed is often encumbered with shoals. The use of sails has not yet been introduced on the Danube to the extent practised on the Rhine and the Vistula; and as the application of steam to navigation on this river is still in its infancy, the alternative in the case of boats going up the stream is to tow them along the banks; but both the towing tracks and the boats are as yet in a very rude state. Unluckily for the commerce of Austria, the course of the Danube is towards countries devoid of mercantile activity, and which offer no encouraging markets for the produce or manufactures it might be made to convey.

The other great rivers in the Austrian dominions are the Save, the Drave, and the Muhr, which convey to the Danube the waters from the eastern face of the Alps. The Marsch or Morawa brings to it the tribute of Moravia, while the still larger streams of the Theiss and Maros collect all that flow from the southern side of the Carpathians. All these rivers abound with fish, and are of sufficient depth to be navigable; but flowing through poor and thinly-peopled countries, they have as yet been of little use in a commercial sense.

Lakes and marshes. Lakes and marshes are both numerous and extensive in the Austrian dominions. In Styria, Tyrol, and other mountainous tracts, they are formed, as in the highlands of Scotland, by water collected in valleys which, from the structure of the ground, are pent up in all directions. In Hungary, Galicia, and other level countries, their origin is different: they are a consequence of neglect of drainage, and of that backward cultivation which prevails in almost all countries until population and agricultural improvement attain a certain height. It was thus that marshes, heaths, and forests covered the surface of England in former ages, and that large tracts are at present lost to every useful purpose along the banks of the Danube, the Theiss, the Drave, the Save, and other rivers in Hungary, which inundate the country, when swelled by heavy rains or the melting of the snow. To drain these low-lying tracts would require skill, capital, and machinery, all of which are wanting in these poor and backward countries.

Mountains. The other striking physical features of the Austrian territory are successive chains of mountains, viz. the Alps in the south-west, and the Carpathians in the north-east of the empire, all of great height and extent. In the bleak climate of Norway the higher parts of mountains present little else than continued sterility; but in the central and southern parts of Europe vegetation is seen to rise to a great height. The base of a mountain is often covered with vines and maize; the ascent with green pastures, or with wheat, barley, and similar kinds of corn. The trees in the lower and middle region are often the oak, the elm, or the ash; while, in the approach towards the summit, the yew and the fir are chiefly seen to brave the fury of the tempest. Many parts of Tyrol, Styria, Carinthia, and Carniola, abound with picturesque views, and recall to the traveller the scenery of Switzerland. Styria, in particu-

lar, has, like that country, its cascades, its glaciers, its perpetual snows, and its tremendous avalanches.

Austria. Climate. German writers are in the habit of dividing the climate of the Austrian empire into three regions or zones, viz. the northern, situate between the 49th and 51st degrees of north latitude, and comprising nearly the whole of Bohemia, with the high-lying parts of Hungary, Moravia, Galicia, and the Buckowine; the whole extending over a surface of 70,000 square miles. The weather in these countries, though colder in winter and warmer in summer than in England, bears, in its average temperature, a considerable resemblance both to our climate and to that of the north of France. In products also there is a remarkable correspondence; wheat, barley, oats, and rye, forming the great bulk of the yearly crops. The middle region of the Austrian dominions is considerably more extensive; containing the whole of Lower Austria, with the chief part of Upper Austria, Moravia, Hungary, Transylvania, and Galicia. It extends along the entire length of the empire, and has a surface of fully 150,000 square miles. This vast tract lies between latitude 46° and 49°. The summer and autumn heats are here much greater than in England; and, in addition to wheat and other products mentioned above, vines and maize are cultivated in favourable situations, as in the middle part of France. Lastly comes the southern region, extending from latitude 46° to 42°, and comprising Lombardy, the Venetian States, the coasts of Croatia and Dalmatia, with the southern line of Slavonia, and the Bannat of Temesvar. In these different countries the winter lasts during two or three months only, and the cold seldom exceeds that of our month of March. Here are raised not only maize and vines, but olives, myrtles, and other southern products, as in the south of France. This temperature extends over a surface of from 30,000 to 40,000 square miles.

We have stated these distinctions of climate according to latitude; but it is proper to add, that in no country does there exist greater difference of temperature in the same latitude, in consequence of the very marked differences in the elevation of the soil; one line presenting a succession of mountains, and another of plains and valleys. Thus, the Alpine Provinces, with the extensive tracts adjoining the Carpathian range, and the lofty barrier between Bohemia and Moravia, partake of all the rigour of the north, though situated to the south of latitude 49°; while Galicia and the interior of Bohemia, though to the north of that line, are considerably warmer, because their surface is in general even, and little elevated above the level of the sea.

The average fall of rain is considerably greater in the mountains than in the plains. In Vienna, and the low-lying tracts generally, 28 inches are a frequent average for the year; but in the mountains it often amounts to 40 inches and upwards.

It remains to state how the summer heats in Austria are considerably greater than in the same latitude in England, while the cold of winter is often more intense. In this country, and still more in Ireland, the vicinity of the ocean induces a frequency of rain, with a medium degree of heat and cold in the prevailing winds, which by no means exist in Poland, Austria, or any country in the interior of the continent. But the transitions from heat to cold, and *vice versa*, are in many parts of Austria as frequent and as remarkable in degree as in this country.

Products, Manufactures, and Trade.

In a country covered in so many parts by mountains, the extent of mineral produce can hardly fail to be large. **Mines and minerals.** Iron ore is abundant in many parts of Bohemia, Upper Austria, Styria, and Carinthia; and if the quantities of tin or copper hitherto wrought in these provinces be com-

Austria. comparatively small, it is owing to most of the mountain districts being as yet imperfectly explored. The mines already wrought in Bohemia afford good tin, and those of Hungary excellent copper. In the latter country, particularly at Schemnitz and Kremnitz, are mines of gold and silver, wrought on the account of government, not from a monopolizing spirit, but because without such aid it would not be practicable to secure continued employment to the natives on the spot, so scanty and uncertain are the returns.

Annual Produce of the Mines of Hungary.

Gold about.....	L.80,000 sterling.
Silver.....	160,000
Antimony.....	250 tons.
Lead.....	1,200 tons.
Copper.....	2,000 tons.
Iron.....	15,000 tons.

Small as is the quantity of gold obtained, the mines of Schemnitz and Kremnitz are visited by foreigners for instruction in that respect, because gold is so seldom found in the more improved countries of Europe. Saxony is far before Austria in scientific knowledge, but its mines are of silver, not of gold; exactly as those of Cornwall are of tin and copper, to the exclusion of the precious metals. The companies lately formed in England for working the gold mines of Brazil have derived useful information from the mines of Hungary.

Coal mines. A far more important mineral than silver ore, we mean coal, has been found in many parts of the Austrian dominions, in Bohemia, Moravia, Austria Proper, Hungary, and Styria; but the quantity raised is large only in situations contiguous to a navigable river. One of the main sources of the superiority of England to other countries, has been the ease of conveying coal in former ages by sea, and latterly also by canals and railways, to situations where fuel is of importance for manufactures. But in a country like Austria, which has no coast, where canals are almost unknown, and railways have been heard of only of late, the opportunities of such conveyance are as yet very rare. This, joined to the abundance of wood fuel, has prevented the working of many coal mines; but they bid fair to be a source of general employment to the lower classes, and of advantage to those who manage them, when manufactures shall be conducted on a larger scale, and the communications assimilated to those of England or the Netherlands.

Salt mines. Similar observations apply to the raising and distributing of rock salt, mines of which are found in various parts of the empire. Those of Bochnia and Wieliecka in Galicia are known to be the greatest in Europe. A number of others are found along each side of the great Carpathian range, and may be said to extend with greater or less intervals all the way from Moldavia to Suabia. This very extensive tract comprehends the salt mines of Wallachia, Transylvania, Galicia, Upper Hungary, Upper Austria, Styria, Salzburg, and finally of Tyrol. They are found either at the base or on the ascent of great mountains, the salt extending in horizontal or undulating strata, and alternating with strata of clay.

Agriculture. To an English traveller agriculture appears in a very backward state, even in the best provinces of Austria. Capital has as yet been applied to it on a very limited scale, while the ploughs and other implements in use are much inferior to those of England. Add to this, that scientific instruction in agriculture, though the subject of various publications in the Protestant part of Germany, is in a manner unknown in Austria and the Catholic countries in the south. Nowhere, however, is there a fairer field for improved husbandry, for no part of Europe presents a greater extent of good soil. Lower Austria has, like Lom-

Austria. bardy, the advantage of extensive plains watered by streams flowing from a range of mountains which form the background of the prospect contemplated by those who travel along the banks of the Danube. Moravia has a similar climate, and almost equal advantages of soil and position. Galicia is likewise fertile, the most so perhaps of any of the Polish provinces; while in the south and east of the empire many of the plains of Hungary and Transylvania might be rendered productive were the population more dense, and acquainted with the method of draining, irrigating, and properly tilling the ground. The land of second rate fertility is in the Alpine provinces. The slopes of the mountains, up to a certain height, are favourable to pasture, and the raising of oats and other like grain; but in many parts the height is so great as to outweigh the advantage of latitude, and to confine the inhabitants to a scanty return for their labour.

Comparative culture of Great Britain, France, and Austria, exhibited in proportions of 100.

	Great Britain and Ireland.	France.	The Austrian Empire.
Land under tillage.....	34.....	44.....	34
Vines, orchards, gardens....	1.....	5.....	3
Land in grass, whether natural or sown.....	40.....	14.....	17
Forests, plantations, copses	5.....	17.....	26
Poorland, as heath, marshes, commons; also land totally unproductive, as rocks, summits of mountains, lakes, beds of rivers, roads.....	20.....	20.....	20
	100.....	100.....	100

Comparative population.—
Inhabitants per square mile.....

Great Britain and Ireland.	France.	The Austrian Empire.
220.....	165.....	130

This table suggests several conclusions of importance. First, the proportion of land altogether uncultivated is nearly equal in the three countries; the mountains of Scotland, the bogs of Ireland, and the commons of England, containing a surface corresponding to that of the high mountains in the Alpine provinces of Austria, and the marshes and sandy levels of Hungary. But the proportion of land covered with forests, and thus lost to useful cultivation, is far greater in France, and still more in the Austrian empire, than in this country. The inducement to convert such land into pasture is far greater in Britain and Ireland, in consequence of our numerous population, and the high price of butcher-meat, wool, and hides. To this is to be added a very different consideration, viz. that the facility with which all our large towns are supplied with coal makes it quite unnecessary to keep up forests, as on the continent, for the purpose of fuel.

Next, as to the land under tillage, the great proportion of such in France is owing to the lower orders living almost wholly on bread and vegetables, to the exclusion of animal food. In Austria the proportion of land in tillage is equal to that in Great Britain; but there is the greatest difference in the nature of the cultivation, the produce in even the best districts of Lower Austria being thirty per cent. less than would be obtained from similar soils in this country. In the nature of the produce there is a considerable resemblance, the bulk of it in either country consisting of wheat, barley, oats, rye, pease, beans, potatoes, along with flax and hemp. Of rye, the proportion raised is larger in Austria; that of potatoes much smaller. Maize is raised in the southern provinces of Austria, as of France, and is said to yield much more nourishment for either

Austria. men or horses than could be obtained from wheat on a similar soil.

Vines.

The northern parts of the empire, viz. Bohemia, Galicia, and part of Moravia, are too cold for vines; but in the central part of the empire they are cultivated extensively, and wine is sold in large quantities for home consumption. The prices of the different qualities vary from sixpence to one shilling a bottle. The port is far inferior to that obtained from France, in consequence chiefly of the want of conveyance. Lower Austria and Hungary, the fittest countries for the vine, have navigable rivers only to the eastward, and these lead to countries which either raise wine for their own use, or are too poor to make purchases from their neighbours. The exports from the Austrian states are thus limited to small quantities of choice wines, such as the well-known Tokay, which is raised on the last chain of the Carpathians, near the district of Zemplin. This wine is cultivated along a tract of about seventy square miles: its qualities are various; the richest kind proceeding from the grape with little or no pressure; while the inferior sort is said to be made from the dried grape, reduced into a sort of pap, and mixed with other Hungarian wines. But it by no means follows that all the wine sold under the fashionable name of Tokay is the product of the district in question; for, even in Vienna, there is not perhaps a tenth of real Tokay among the wines which bear that name.

Manufactures.

Manufactures have in the last and present age received considerable extension in the Austrian dominions. They are still, however, on a footing very different from those of our country. In England they are generally conducted on the plan of particular towns or districts restricting themselves to specific branches; as Manchester to cottons and Birmingham to hardware. Hence our minute division of employment, our nicety in workmanship, and the surprising quantities produced. But in Austria the case is different: woollens, linen, hardware, and of late years cottons, are made in almost every place of considerable population; a sure proof that their establishments are on a small scale, and that they avail themselves very imperfectly of local advantages or of the division of labour. In many parts, indeed, weaving and other sedentary work is performed in cottages, as was the case in England a century ago. Spinning wool and flax has from time immemorial been the habitual employment of the lower class of females in Germany; and still continues to be so, notwithstanding the competition of machinery. Linens are woven in every province of the empire; but the finest qualities are made in Lower Austria, Moravia, and certain parts of Bohemia. These countries supply little for export beyond the limits of the empire, but a great deal to the adjacent provinces. Woollens also are a very general manufacture throughout the empire. As to hardware, the mines in the mountainous districts supply an ample store of materials, the manufacture of which takes place partly on the spot, partly in the larger towns, such as Vienna, Prague, and Karlsbad. Bohemia is remarked for the number of its glass works, a consequence of fuel being cheap in several districts which have the advantage of water conveyance. Hungary, Transylvania, and the Buckowine, having extensive pastures, as well as forests containing vast herds of cattle in a wild state, hides are an article of export from the same cause as in the thinly-peopled provinces of Russia or the wilds of Buenos Ayres. A very different object of trade, paper, is also made to a considerable extent in the Austrian states, in consequence of the cheapness of linen rags.

All these are manufactures of old date; but cottons are comparatively of recent introduction, and are confined to Vienna and some of the principal towns. The cheapness

of labour is in favour of such undertakings in Austria; the obstacles to it are the distance which the raw material, whether landed at Trieste or at Hamburg, must be brought by land, as well as the inferiority of the machinery to that of England.

Comparing these different manufactures with those of an improved country like England, we find the foreign articles generally higher in price and more homely in appearance, but at the same time more durable than ours. This distinction is found to hold in regard to fabrics the most different in their nature; the muskets made in Germany and France being heavier, exactly as their woollens, cottons, and linens, are thicker than ours. Lightness of workmanship and dispatch in completing an article are the result of long practice: the comparatively limited experience of foreigners, and their imperfect subdivision of work, require both longer time and a larger consumption of raw materials.

In her intercourse with foreign countries, Austria experiences all the disadvantages of an inland position, and of a very limited access to the sea; the portion of coast belonging to her being in a corner of the empire. Its extent is about 500 miles, comprising the north and east shores of the Adriatic, from the mouths of the Po on the west, to Ragusa and Cattaro on the east. The commercial sea-ports are Venice, Trieste, and Fiume; the first being the inlet to Friuli and Lombardy, the second to Carniola, and the third to Croatia. From Venice the access to the interior is easy, the country being flat, and admitting of intersection by canals; but Fiume, and still more Trieste, have to the east ranges of mountains, over which the transport of bulky commodities is attended with great labour and expense. Roads to the interior have been made at the public charge; and it is said that the canal now making from Vienna to the southward may perhaps be continued until it connect the Danube with the Adriatic; but that must be the work of a future age, and of means far greater than can be applied to it by any mercantile association, the distance being fully 300 miles along a line on which, if the mountains be avoided, it would be indispensable to erect aqueducts over the numerous rivers that flow from them. The expense of so vast a work could be defrayed only by the government; who, aware that improved roads are more useful for military purposes than canals, are likely to prefer that mode of employing the funds of the public.

Venice was made a free port by the Austrian government in 1830, and the inhabitants have hopes of recovering in some degree their former prosperity. Trieste is a port of considerable activity; the shipping belonging to it exceeds 100,000 tons, manned by about 6000 seamen.

The harbours along the coast of Dalmatia are both numerous and commodious, but their trade must be inconsiderable until the country inland acquire population and wealth. In the northern part of the Austrian empire there are also great obstacles to foreign trade. Bohemia communicates with the sea only by the Elbe, and Galicia with still more difficulty by the Vistula. Here there are vast tracts of level country, alike favourable for canals and for improved roads; but the distance to the sea from even the northern line of the Austrian territory is great,—almost 200 miles to the Baltic, and 300 to the German Ocean.

National Income and Finances.

In commercial countries, like England and Holland, the public revenue arises principally from the excise and customs; but in a country chiefly agricultural, such as France, and still more Austria, the case is very different. In these the limited extent of foreign trade renders the customs comparatively small; while the small number of towns, and

Austria. their scanty population, lessen greatly the produce of the excise. An extra share of the public burdens must therefore fall on land, the assessment of which ought from time to time to be altered according to the amount of rents. In England, since the first imposition of the land-tax in 1692, there has been no renewed survey, or attempt to adapt it to the augmented rental; but in France and Austria the absolute insufficiency of other taxes rendered an increase of the land-tax indispensable, and the *foncière* in France is now collected on a valuation made so lately as 1815. In Austria, the emperor Joseph, among other changes, proposed a land and poll-tax on a uniform plan, and attempted a general survey of the empire. Several years were devoted to this great work; but it encountered many obstacles, as well from the difference of value between the plain and mountain territory, as from the difficulty of computing rents in almost any province of the empire, the property of the peasantry obliging them to pay their landlords in produce or in labour instead of money. Since 1815 the Austrian government has endeavoured to correct defects in the existing assessment, but it is still in a very imperfect state. In the Hereditary States, as well as in Bohemia and Galicia, the land-tax is levied without distinction of class or rank; but in the aristocratic countries of Hungary and Transylvania the *noblesse* or gentry are exempt from it.

Public Revenue of Austria.

	Sterling.
Land and house-tax, corresponding to the <i>foncière</i> in France.....	L.5,000,000
Poll or personal tax paid by the Jews.....	300,000
Poll or personal taxes on the other inhabitants of the empire.....	1,200,000
Inland customs collected on the frontiers of the different provinces.....	L.500,000
Salt duties.....	650,000
Monopoly of tobacco.....	300,000
Stamps.....	350,000
Liquors.....	250,000
Post-office.....	100,000
Lottery.....	200,000
All other indirect taxes.....	650,000
Total of indirect taxes...	3,000,000
Crown revenue—from the forests.....	L.800,000
from the mines...	500,000
from the demesnes or lands.....	200,000
	1,500,000
Import duties, and all other sources of revenue.....	2,000,000
Total net revenue.....	L.13,000,000
Public debt, after reckoning the reductions since the peace of 1815, about.....	75,000,000
Amount of government bonds in circulation.....	8,000,000

The cost of collecting the revenue, which in England is not quite five per cent. on the amount, is in Austria ten per cent.

The Austrian government has not yet, like the English and French, adopted the plan of giving their finance accounts to the public. There are thus no satisfactory means of estimating the amount of national income, even that arising from the rent of land and houses throughout the empire; but as the two together can hardly amount to thirty millions sterling a year, perhaps not to twenty-five millions, it follows that of all income in Austria arising from real property, L.20 in L.100 are paid, even in time of peace, to the public treasury. The poll-tax on the Jews is a toleration tax. The next head in the list, viz.

Austria. the inland customs, arises chiefly from the difference in taxation between Hungary and the Hereditary States. Dues are consequently collected on the transit of certain articles from one to another, as was the case between different provinces in France before the revolution. The duty on salt, though not high, is injurious both to agriculture and manufactures, by limiting the consumption. As to tobacco, there is no duty in Hungary and Transylvania; but in the rest of the empire the government, like that of France, keeps in its own hands the exclusive manufacture and sale.

The tax on liquors, slight in its rate, is small in its produce, from the limited population of the towns: in country parts, where the population is thin, the excise does not repay the expense of collecting. But nothing in the fiscal list is more interesting to a statistical inquirer than the net receipts from the post-office, which in this country are L.1,200,000 a year; in France L.600,000; in Austria only L.100,000. What can show more clearly the limited correspondence and the scanty traffic of this great empire, or that the badness of the roads is productive of an expense which more than balances the low wages and general cheapness in the post-office establishment?

The imperial demesnes or crown lands yield about L.200,000 to the treasury, a sum to be carefully distinguished from the personal property of the reigning family, of which the yearly rental amounts to about L.100,000.

Among the lesser imposts in Austria, not specified in the above table, are those on carriages, pleasure-horses, hair-powder, starch, as well as legacy-duties, and fees on titles of nobility. The list of taxes, in short, is nearly as long in Austria as in England, and the complaint of their pressure almost as general. What, then, are the causes that, with so fertile a soil and so numerous a population, the public revenue of Austria should be so inferior to that of France? The inquiry is interesting, and the causes are briefly as follow.

In manufacturing and commercial countries, such as England or the Netherlands, agriculture is conducted with the benefit of capital and machinery; and the labour of 30 or 40 persons in 100 is sufficient to raise subsistence for the community at large. But in the other countries of Europe the case is very different, the labour of half or of more than half the inhabitants being required to raise the needful subsistence. Thus in France, a great part of which is more backward than an untravelled Englishman can readily conceive, between 50 and 60 persons in 100 are and must be employed in country work, in consequence of the great inferiority of their agriculture, their farms being small, their ploughs and other implements miserably defective, their capital scanty, and machinery, such as threshing-mills, in a manner unknown. Hungary, Transylvania, and the southern frontier along the Danube, being still more backward than any part of France, more destitute of capital, and more deficient in machinery, the consequence is, that of the average population of the Austrian empire, the labour of not fewer than between 60 and 70 persons in 100 is needed for raising provisions; thus reducing to a comparatively small number the population of the towns, the persons disposable for trade and manufacture. This is at once apparent from a comparison of the town population in these different countries. If we make it between France and England, we shall obtain a result decidedly favourable to England; but a comparison of France and Austria exhibits, in almost every case, a greater number in the towns of France. Thus,

The twelve largest Towns in France.

Paris.....	850,000
Lyons.....	140,000

Austria.	Marseilles.....	115,000
	Bordeaux.....	100,000
	Rouen.....	95,000
	Nantes.....	80,000
	Lille.....	65,000
	Strasburg.....	50,000
	Toulouse.....	50,000
	Orleans.....	45,000
	Metz.....	45,000
	Nismes.....	40,000

The twelve largest Towns in the Austrian Dominions.

Vienna.....	300,000
Milan.....	160,000
Venice.....	115,000
Prague.....	90,000
Pesth and Buda (they are contiguous)...	70,000
Verona.....	55,000
Lemberg (in Galicia).....	54,000
Padua.....	48,000
Debretzin (Hungary).....	42,000
Presburg.....	42,000
Trieste.....	42,000
Grätz.....	35,000

Of the twelve places cited above for the Austrian dominions, no less than five are in Italy, so deficient is the rest of the empire in town population. Of the total number of its inhabitants (33,000,000), it is computed that three fourths, or 25,000,000, reside in the open country.

Comparative density of population.

Another very important point in estimating the resources of different countries, is the degree of density in the population generally. In England, by the census of this year (1831) it is nearly 220 persons to a square mile; in France, about 165; in the Austrian empire, under 130. Now it almost always happens that in a thickly-peopled district the wages are better and the consumption of taxed articles greater, per head, than in one that is thinly peopled; and hence the contribution to the public treasury is larger. Thus the inhabitants of Lombardy, Bohemia, and the Vienna district, pay considerably more per head than those of Hungary, Carinthia, or Upper Austria. Add to this, in the third place, that while England has all the benefit of an insular situation, and France possesses an extensive line of coast, with considerable trade, the maritime provinces of Austria are both limited in extent, and but recently acquired; in short, the empire may be said to have as yet wanted almost entirely the stimulus to industry arising from communication by water. In the fourth and last place, in the remote provinces of the Austrian empire, particularly on the side of Turkey, the contributions of the subjects to their sovereign are made, not in money, but in military service.

All these reasons tend to one point: they account for the money payment in name of taxes and all public burdens in Austria not exceeding twelve shillings a head, whilst in France it is double; and for the net revenue of the Austrian empire not exceeding thirteen millions sterling, while that of France is above thirty millions. Accordingly, in forming a *bona fide* estimate of their resources, we have to make an addition on the side of Austria on two grounds: first, for the greater value of money in that country; and next, for the frontier provinces discharging their contribution to the state by military service in lieu of taxes. It follows, that in estimating the financial means of the two countries, we shall not materially err in assuming them to bear the proportion of twenty to thirty; in other words, that were the total contribution of the subjects of the emperor to be discharged in money, and in money of the value borne by the circulating medium of France, it would amount to about twenty millions sterling a year.

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Austria, like England, has a sinking fund, and one of which the operations are equally vaunted; but in either country the only true sinking fund is the extension of the national industry, and a reduction of the interest of the debt consequent on continued peace, and on a general abatement in the interest of money.

Military Establishment.

Austria has taken so prominent a part in the wars of the last and of the present age, that the nature and extent of her military means are subjects of great interest. The disposition of the inhabitants of Hungary, and of the more remote provinces of the empire, is well adapted to a military life. They are accustomed to pass their time out of doors, to indulge in active exercise, to follow the chase, and to occupy themselves with the care of horses. To such men marching and encamping are but a slight deviation from their established habits. The fire of the nightly watch is not more uncomfortable than that of their smoky cottages; whilst a loaf of bread, a slice of coarse pork, and a glass of spirits, are all the food and drink they desire. But to accustom these rude combatants to the restraints of discipline was found no easy task: still the Austrian government judged it indispensable to their meeting on equal terms the armies of France and Prussia. It is now somewhat more than a century since the Prussians began to take a lead in military discipline, the father of Frederick II. having carried both the manual and platoon exercise to a nicety unattempted by almost any other tactician. He left a highly disciplined army of nearly 80,000 men to his son, who, on the death of the emperor Charles VI. in 1740, conceived that such a force would soon enable him to accomplish the conquest of Silesia. He lost no time in making preparations for war. The court of Vienna, alarmed, sent a special envoy to dissuade him from it; but Frederick was not to be deterred by any remonstrances, however urgent. The envoy adverting, on the one hand, to the careful training of the Prussians, and on the other to the recent practice of the Austrians in the field, declared to the king, "*Vos troupes, Sire, sont belles, mais les nôtres ont vu le loup.*" "*Vous convenez,*" replied the king, "*que mes troupes sont belles, je vous ferai convenir qu'elles sont bonnes.*" The words of the king were made good; the events of the war which ensued, as well as of the more arduous contest begun in 1756, having proved, on many trying occasions, the great advantage of a high state of discipline. This led the Austrian generals and war ministers to follow the example of the Prussians, as well by carefully training their infantry, as by new-modelling the "free corps" of horsemen, Croats, Slavonians, and Hungarians, who had hitherto been left to their national mode of fighting. By dint of perseverance, Marshal Lascy and other military men in Austria succeeded at last in bringing these half-civilized combatants under the discipline of regular cavalry.

The French, in the wars of the revolution, were remarkable for celerity of movement in collective bodies, but bestowed comparatively little attention on the *minutiae* of discipline. The Austrians were charged with following a contrary system; with too much care as to details, and too little as to general movements. Their lines are said to have suffered on various occasions, in particular in the dreadful conflicts at Essling and Wagram, from continued exposure to the field-pieces of the enemy; and their infantry was said to be slow in executing most movements except those from front to rear. Their own officers, however, did not admit this inferiority; and whatever may have been the case in the last age, there is reason to believe that the Austrians have now attained that celerity of movement which has so long distinguished their rivals in

Austria. France and Prussia, and which became so conspicuous in our own troops after their first campaigns in Spain.

Military education. In former times the Austrian government, conscious of the deficient education of its subjects, gave important commands to Italian officers, amongst whom the most remarkable were Montecuculi and Prince Eugene. At present there are military schools at Vienna and several of the provincial towns; and as these have of late been much improved, another generation will probably witness the removal of the charge of deficient instruction from the Austrian armies.

It is unnecessary here to enter into any particulars regarding either the absolute numerical strength, or the relative apportionment and distribution of the Austrian military establishment, at the present time, seeing that these subjects have been already treated of under the proper head in the article ARMY, where detailed information, derived from the most authentic sources, is given respecting the constitution, organization, discipline, divisions, and numbers of this establishment, as well as of its different branches or arms separately. In referring to the above article, however, it is proper to add, that recent events, particularly the contest in Poland, coupled with the actual state of affairs in France, Italy, and the Netherlands, have produced a considerable augmentation of the disposable military force of Austria. (June 1831.)

Mode of recruiting. In most of the provinces of the Austrian empire the levies are at first made for militia service (*landwehr*), and the regular regiments are kept up by successive draughts from that force. But in Hungary, recruits are raised at once for the regular service, the emperor proposing a specific number to the diet, who deliberate on the demand; and on its being assented to, the magnates or great landholders undertake to levy their respective proportions on their estates.

Horses and equipments. The horses for the Austrian light cavalry are drawn from Hungary and Galicia; those for the heavy cavalry chiefly from Bohemia and Moravia. Clothing, arms, ammunition, and harness, are all furnished at different stations, in Bohemia, Moravia, and the Hereditary States. The duration of military service in Austria was long unlimited; but in the early part of the present century it was reduced, as in this country, to specific periods. For invalids and veteran soldiers there is a provision similar to what is made for our military; they are either received into hospitals or allowed small out-pensions.

Magnitude of the resources of Austria. The limited revenue of Austria, and her equally limited credit in a financial sense, prevent her from making a great military exertion at short notice. She cannot, unless when aided by English subsidies, equip for offensive operations, or send to a distance, armies of any very considerable force. Hence her power in attack is restricted so as to form a remarkable contrast to the extent of her means for continuing a contest by filling up the blanks in her regiments, year after year, by fresh levies. In her long and arduous struggle with France, the losses of each campaign appeared to be supplied without making a serious impression on her numbers, or distressing her productive industry. The causes of this are obvious. A country like England, possessing monied capital, can at short notice embody an army, and send it to a distance, amply equipped and provided; whilst an agricultural nation like Austria is limited in its extent of exertion at the moment, but, from the amount of its population, almost indefinite in its resources. The long duration of several of her wars is to be ascribed to two causes; her inability, on the one hand, to overpower her opponents by a great effort; and her power, on the other, to keep up a certain degree of exertion for a long period. It was thus that Austria carried on the contest in Germany about religion during thirty years, and persisted in the war with France in

1713, after England and Holland had withdrawn. Maria Theresa would have done the same towards Prussia in 1763, had she not been forsaken by her allies; whilst, in the wars with revolutionary France and Buonaparte, we have seen Austria, worsted in five successive contests, return as often to the charge.

The Austrian navy is as yet merely in an incipient state, but is entitled to notice, because the possession of Venice, Trieste, and the fine harbours along the coast of Dalmatia, hold out a prospect of its being, in course of time, considerably increased. At present it is confined to a few ships of the line, dismantled or cut down, eight frigates, as many corvettes, and about twenty brigs and sloops. Venice is the naval station.

Religion, Education, National Character.

The population of the Austrian empire, classed according to their respective creeds, will stand thus: Catholics 26,000,000, Protestants 3,000,000, Greek church 3,000,000, Jews 500,000, other religions 500,000.

Although Austria took, two centuries ago, so decided a part against the Protestants in the north of Germany, her internal tranquillity was never disturbed by religious contests except in Bohemia, the country of the unfortunate John Huss and Jerome of Prague. Her sovereigns have been tolerant from character, if not from conviction; and during the last half-century indulgence to Protestants and other dissenters has existed in a liberal form. The north and west of Germany frequently exhibit Catholic and Protestant communities in the same vicinity; and nowhere are the superior industry and intelligence of the latter more strongly marked. The traveller who passes from Saxony into Bohemia cannot fail to regret that the reformation should not have made its way into the Austrian dominions: the result would doubtless have been a very decided advancement in science and productive industry. Literature, manufactures, trade, would then have been cultivated in the south and east of Germany with the same zeal, and probably the same success, as have marked their progress in the south and west. At present we can hardly flatter ourselves with any considerable number of converts to Protestantism. The Catholic clergy are in general assiduous in the discharge of their duties: they possess the attachment of their flocks; and the Austrian people at large are too little enlightened to exchange a worship which dazzles the imagination by its pomp and ceremony for one which appeals chiefly to the understanding.

In Austria, as in France, the Catholic clergy are generally educated in humbler seminaries than universities. Oratory forms no part of their studies, and would, in fact, be misplaced before a German congregation, which meets for the purpose of fulfilling, soberly and tranquilly, a religious duty. Sermons therefore are, in almost all parts of the Austrian dominions, little more than plain moral lessons deduced from the sacred writings; and the reputation of a clergyman, particularly in country parts, rests chiefly on his attention to the sick, and the performance of private and unostentatious duties. But while the country curates and other inferior clergy are thus assiduous and unassuming, the conduct of the heads of the Romish church has often been very different. Protestants who have not lived in a Catholic country can hardly conceive the extent of the pretensions made by the popes in former ages, or which they are still disposed to make in the less enlightened parts of Europe. These the sovereigns of Austria have in general resisted; reserving to themselves several important rights, such as the imposing of taxes on church property, the nomination of bishops and archbishops, and the option of restricting or even preventing the circulation of papal bulls.

Austria.

The extent of landed property in Austria belonging to the Catholic church is very considerable, as may be inferred from the number of abbeys and convents. Though a good deal reduced within the last half-century, there are still nearly 300 abbeys and above 500 convents in the empire. The head of the Austrian church is the archbishop of Vienna; but the bishop of St Polten appoints the regimental chaplains, and is the superior of all clergymen doing duty with the army.

The followers of the Greek church are chiefly in Galicia, Hungary, Croatia, and Transylvania, forming a total of 3,000,000. They are in a state of gradual increase, as well by the progress of population as by arrivals of their brethren from Turkey. Galicia comprises a body of Armenian Catholics, and there are a few of that sect in Hungary. The well-known association of Hernhutens or Moravians took their origin from that province in the middle of the eighteenth century. The emperor Joseph, in his ardour for toleration, extended it to Jews, and even to Mahometans; but he found that the Jews were hardly in a state to be incorporated with the rest of his subjects, or to take advantage of the privileges held out to them. Their old habits and prejudices remain; so that ages will be required in Austria, as in Poland and other backward parts of Europe, before they can be identified with their Christian neighbours. In tolerating Mahometanism, Joseph had in view the vicinity of Turkey, and the importance of inducing traders from that country to travel and settle in his dominions.

National education.

A deficiency in national education has long been a subject of reproach to the Austrians, and their apathy in regard to literature and politics is often ascribed by foreigners to restraints on the press. But these restraints, slight in their nature, are by no means intended to check useful inquiry. The truth is, that the majority of the Austrians are occupied with the tranquil enjoyment of the good things of life: they are unambitious, uninquiring, and, in general, satisfied with following a beaten track, with going over the same routine as their fathers and forefathers. The desire of acquiring property is, of course, as strong or nearly as strong in this as in other countries; but the inhabitants have still to acquire that intellectual activity which stimulates so largely to exertion in England, in France, and, above all, in the Protestant part of Germany. Saxony is the centre of literature for that country; and the society which is within the reach of a youth at the university of Vienna is not to be compared to that of Dresden or Leipsic. The Austrian dialect of Germany is unpleasant, having a slowness of accent and a hissing tone, particularly in the mouths of the lower orders. Hence French is the language used not only at court and by diplomatists, but by genteel society generally. The universities in the Austrian empire are as follow: Vienna, Prague, Pesth in Hungary, Lemberg in Galicia, Inspruck in Tyrol, Grätz in Styria, and Padua and Pavia in Lombardy; in all eight universities, attended by nearly 7000 students. There are seven academies, and thirty lyceums or high schools. Of military schools there are in all ten in the empire; the two principal in Vienna, the others in provincial towns. The primary or elementary schools throughout the empire correspond in some measure to the parish schools in Scotland. They were greatly increased half a century ago in the reign of Joseph II., and in the Austrian provinces they appear to be adequate to the wants of the population; but in Hungary and the remote parts of the empire there are still great deficiencies in the provision even for this, the first stage of education. The university of Vienna dates from the middle of the thirteenth century, the time when the residence of the court, being fixed in that city, began to

give importance to it, and to call for improvements in public education. It was long under the management of the clergy, who in the middle ages were the only men of letters; but, a century ago, Von Swieten, the celebrated physician, induced the government to take it into their own hands, and to give a great extension to the medical department; Vienna, from the number of its inhabitants and the extent of its hospitals, being much fitter for a medical school than any other city in Germany. The consequences of Von Swieten's representations were the fitting up of a botanical garden, an anatomical theatre, a military hospital, and, at a subsequent date, a veterinary school. The university of Vienna is thus at the head of the medical schools in Germany. It contains also public classes for law, theology, classics, philosophy, and general literature, in most of which the reputation of the professors is respectable, though not greater than in other universities, such as Göttingen, Leipsic, and Halle. The number of students at the Vienna university is from 1200 to 1500. Vienna contains also an academy for the fine arts, a seminary for the eastern languages, and facilities for the study of modern Greek. Among the military institutions are a school for cadets, and of late years a polytechnic school for engineers. This capital has also several seminaries like the *Ecole Normale* at Paris, for training teachers for provincial towns and villages. The imperial library at Vienna is very extensive, as is the collection of medals and coins. The university of Prague is of old date, and well attended by Bohemians, but it does not rank high in the scale of German seminaries. Pesth, Lemberg, Grätz, and the other universities, are of importance only to the population of their respective towns and their vicinity.

In travelling for instruction, the Austrians, like the French, are far behind our countrymen, in consequence partly of the want of pecuniary means, partly of their unambitious and uninquiring character. Individuals, however, may be cited among the Austrians, who, like Baron Humboldt among the Prussians, have traversed remote regions in quest of information; but their number is small when compared with the extent and population of the empire. Still Austria can boast of several names of eminence in literature. Of this class are the two Schlegels, one of whom, Frederick, has long been known by his publications on the language and philosophy of India; while his brother has acquired reputation by his translation of Shakspeare and his works on dramatic criticism. Hammer, the founder of the Oriental Society at Vienna, has long been known for his acquaintance with Persian literature; but the majority of Austrian writers have given their attention less to works of imagination than to classics, geography, and statistics. These studies, requiring rather continued attention than vivacity or power of imagination, are best suited to the laborious habits of the Germans.

In painting and sculpture, as in architecture, the Austrians have as yet made no great figure; but the case is very different in regard to music. Haydn and Mozart were both formed at Vienna; and it has been said with truth, that a foreigner can hardly receive a higher gratification than by being present at the oratorio at Vienna in commemoration of Haydn. If in vocal music the Germans are inferior to the Italians, they fully maintain the competition in instrumental performance. In short, the passion for music exists here in the humblest ranks, and under circumstances apparently the least favourable to it. The traveller, in passing through villages, observes wandering musicians performing on the most homely and imperfect instruments. He finds this equally in the populous districts adjoining the Danube, and in the secluded spots of Tyrol and Carniola.

Austria.

Austria.
National
character.

Statistical writers class the population of the Austrian empire according to national descent, thus,

Of German origin.....	6,000,000
Of Italian.....	5,000,000
Of Jewish.....	500,000
Of Slavonian.....	15,000,000
Of Magyar.....	4,500,000
Of Wallachian.....	2,000,000

The Slavonians (called in Latin *Slavi* or *Sclavi*, and in their own language *Slowacs*) inhabited, in remote ages, a part of the vast tract of country known to the ancients by the name of Scythia. Their descendants are widely spread; for their language and habits are to be traced in the Illyrian provinces, in Hungary, Poland, the east of Germany, and even in the western frontier of Russia. They form the most backward and uninstructed portion of the population of the empire; being generally employed on common country labour, and many of them being still in a state of servitude. The Wallachians are almost equally backward; but the Magyars, though illiterate, are a spirited race, averse to sedentary work, accustomed to exercise in the open air, and prompt in obeying a summons to military duty.

In Styria, Carinthia, and other mountainous tracts, the manners of the inhabitants are very primitive. Content with the produce furnished by their lands and cattle, and as cheerful and frank as moderate desires can make them, they seem to have no wish beyond the limits of their native districts. They are, it must be allowed, very ignorant and superstitious; being still blindly attached to traditional usages, and among others, to that of making pilgrimages to a distance as the best means of obtaining forgiveness for trespasses.

The character of the Germans in the Austrian dominions is in general entitled to praise. Sincerity, industry, and habits of order, are all conspicuous in them; and the number of criminal offences committed among them is remarkably small. In many extensive districts year after year passes without a necessity for capital punishment. The French soldiers, who, in marching through Austria, were very often lodged in detached cottages, and at the mercy of the inhabitants, bore a favourable testimony to their humanity; and there scarcely occurred, either there or elsewhere in Germany, any example of those secret assassinations which were unfortunately so prevalent in Spain.

The habits of the females in Austria, in the large as in the small towns, are very domestic. Without taking so active a part as French women in either business or conversation, they claim regard for a steady fulfilment of the duties of wives and mothers. The lower orders have similar habits; and a traveller may visit village after village without hearing of a single instance of domestic dissipation. The care of children, the performance of their daily tasks, and punctual attendance on divine worship, seem to occupy all their thoughts.

A striking feature in the national character of the Austrians is a continued equanimity, a general good humour and forbearance, as if they had little or no cause for complaint in regard either to individual circumstances or public affairs. This fortunate disposition seems the result of various causes; of an habitual acquiescence under their superiors; an unacquaintance with the state of other countries; and in fertile districts, such as the banks of the Danube, of a general abundance of provisions, and an exemption from penury.

But as in national character almost every good quality has a corresponding drawback, that habitual content, and aversion to change, which has kept the Austrians tranquil amidst the convulsions of other countries, is connected

with a blind adherence to old usages, and a disinclination to almost every kind of innovation. Hence their stationary condition, their backward agriculture, their slowly improving manufactures, and their extravagant deference to hereditary rank—a deference often dearly paid for in war, when men of inferior talents have been intrusted with important commands. On the whole, it must be admitted, that no country in Europe stands more in need than Austria of the benefits arising from the diffusion of knowledge. This applies to the upper as well as to the lower classes. In former times the government partook of the national prejudices, and exhibited strong indications of it in their conduct both in the cabinet and the field. This is forcibly stated in the memoirs of one who had long and arduous contests with them; we mean Frederick II. of Prussia. The court of Vienna was, he said, altogether untractable in negotiation, after obtaining even a partial success in the field, or whenever it had any prospect of success; at the same time that it evinced no discrimination in the choice of its general officers. In the campaign of 1744 Frederick entered Bohemia with a strong army, and soon overran the whole country; but the veteran Marshal Traun being sent against him, found means, with an inferior force, so to straiten the Prussian army as to oblige it to quit one position after another, until it evacuated the whole kingdom. "Yet this man," says Frederick, "whom I have ever since regarded as my master in the art of war, the court of Vienna removed next year from the chief scene of operations, and sent to Italy with an inferior command." In our own days similar disappointments have been but too often caused by the Austrian cabinet; in 1796, when Marshal Clairfayt was led to resign, after a very brilliant campaign; and in 1805, when a great army was intrusted to General Mack, who, far from having acquired a reputation, had failed in almost every thing he had attempted.

We should, however, err greatly were we to suppose the apparent slowness of the Austrians indicative of deficiency of invention. On the contrary, their tranquil and sedate habits are more favourable to original combinations than the sprightliness of the French. But in Austria, as in other parts of Germany, mechanical ingenuity is often applied rather to make a display of skill, or to gratify a fancy, than to accomplish a useful purpose. In one part of a journey through that country a traveller finds a machine so framed that, with a slight impulse, it performs the functions of a chess-player; in another part he sees a head which may be made to imitate the human voice; and in a third place, an instrument uniting the most varied sounds of music. In machinery, as in politics, the speculations of the Germans often bear evidence of considerable ingenuity, but at the same time of the absence of practice and experience.

Government and Laws.

Having described the constitutions of Hungary and the other countries under their respective heads, it remains merely to state the part of the political system which is referable to the empire at large. The executive administration for the whole of the Austrian dominions is vested in the emperor, and is exercised at Vienna in nearly the same manner as that of France and England in their respective capitals. At Vienna, as in London and Paris, the chief public offices are the treasury, the home department, the foreign affairs, and the army; to which are to be added, the boards for the affairs of Hungary, and for the general superintendence of the mines. The name of Aulic is not confined, as is generally supposed, to the military board; it is given to several councils or boards, among others to that of the treasury.

Austria.

Austria.
Con-
nection with
the Germa-
nic body.

The Germanic confederation bore, as is well known, during many centuries, the name and form of an empire, consisting of a number of separate states, of which Austria was by far the greatest. Her dominions in Germany comprised Bohemia, Moravia, and Silesia, in addition to the circle of Austria, which contained Austria Proper, Styria, Carinthia, and Carniola; hence the successive election, during nearly four centuries, of the head of the house of Austria to the rank of the emperor of Germany. This dignity being renounced by Francis II., the present sovereign, in 1806, the connection of Austria with the rest of Germany on the previous footing was dissolved: nor was it renewed in the final adjustments of 1815, by which the Germanic body was declared a confederation, but not an empire; for it has no longer an acknowledged head, questions affecting the confederation at large being discussed in the diet or assembly of deputies from the different states, and determined by a majority of votes. Each confederate state is pledged to supply, when required by the diet, a military force proportioned to its population. Austria having in Germany a population of ten millions, her quota in time of war is nearly 100,000 men; that of Prussia is 80,000.

The Here-
ditary
States.

Since the abrogation of the imperial form in Germany, the "Circle of Austria" is no longer an official designation; but the name of "Hereditary States," so often used, has reference to the same provinces, viz. Austria Proper, Styria, Carinthia, and Carniola, which during five centuries and upwards have belonged to the house of Hapsburg by hereditary descent. In these the authority of the emperor, though exercised with mildness, is almost uncontrolled. He is the head not only of the executive power, but of the church, and virtually of the legislature. The Hereditary States have parliaments, composed, as in Hungary and Bohemia, of the Catholic prelates and the nobility, with deputies from the landholders and free towns; but they meet seldom, and never fail to give a ready assent to the propositions of the sovereign.

Diversity
of consti-
tutions.

There exists considerable diversity in the constitutions of the component parts of the Austrian empire, particularly in regard to their origin and date. The constitution of Lower Austria is founded on a charter granted so long ago as the year 1156. Hungary claims to be governed by laws of still older date, the first going back to the ninth century, others dating from the thirteenth; while in Bohemia, confirmations of the privileges of the nobility, and restrictions on the executive power, were enacted so lately as the seventeenth and eighteenth centuries. Galicia, differing in several respects from these countries, traces part of its political constitution no farther back than its annexation to Austria in 1773. Notwithstanding all these discrepancies, it is in one quarter only, we mean Italy, that the sovereign of Austria has to apprehend deficient loyalty on the part of his subjects. In the other states of his empire, however remote from each other, however different in language or national manners, the prevailing feeling is attachment to the government and aversion to change. Nothing could show this more clearly than the steady loyalty of the people during the repeated invasions of the French, and their ready assent to the levies which year after year filled up the blanks in the imperial regiments, caused by a contest at all times sanguinary, and often unsuccessful. And even as to Italy, although the mountains which separate it from the north are as lofty and rugged on the side of Austria as of France, there are in the former no intermediate states like Switzerland and Piedmont; and hence the ease with which an army may march from Germany to Lombardy, and the promptitude with which it may put down insurrection.

Law.

The judicial body in Austria is far more numerous than

in this country, the difficulty in travelling requiring that there should be courts of justice in a great number of provincial towns. Their salaries are greatly below our scale, the profits of pleaders being too small to disincline even the most eminent from relinquishing their business. The administration of justice in Austria long took place, as in this country, by reference to ancient usage, and to a multitude of decisions, without much system or consideration of general principles. The perplexity attendant on this vague and undefined course being doubly felt in a country where individuals were in general ignorant, and the press inefficient, the government became aware, so long ago as the middle of last century, of the necessity of publishing the laws in a collective form. Accordingly, in the year 1767, a code was published in eight folio volumes. This was a first step towards improvement; but the work, from its bulk and its deficient arrangement, proving of little use, instructions were given by the government to an eminent civilian named Von Horten, to recast it in a condensed and improved form. This was necessarily a work of great time and labour, and it was not till 1794 that the first part of the civil code came forth in an improved shape. The remainder followed in a few years, when printed copies were distributed in all directions, and local commissions appointed to report on its applicability to the usages of the different provinces of the empire. At last, in 1812, the civil code was definitively promulgated, and applied to practice. With the criminal code a similar course had been adopted somewhat earlier; it had been promulgated in 1803, and introduced into practice the year after. Fortunately, the number of criminal offences in Austria is small compared with the magnitude of the population.

Austria.

Foreign Politics of Austria.

We shall conclude this account of Austria with a few remarks on her situation in regard to the great powers who are her neighbours. To begin with France: It is now about three centuries since Austria, by the definitive acquisition of Bohemia and Hungary, became equal to France in extent of territory, and ventured to contend with her for ascendancy both in Italy and the Netherlands. In fertility of soil Austria is fully equal to her rival, but in other respects France has had and still has great advantages. Her people all speak the same language, and the country is to a certain degree maritime; main points in facilitating intercourse, and in promoting civilization, trade, and national wealth. Hence the greater increase of the towns; a more general diffusion of education; and a larger proportion of intelligent public officers, of able statesmen and commanders. Add to this, that while France was relieved from intestine troubles so early as the year 1600, or the reign of Henry IV., Austria did not obtain the complete attachment of her subjects in Hungary and the eastern provinces until 1720, more than a century later. The consequence of all this was, that with a few exceptions, such as the brilliant reign of the emperor Charles V., or the still more brilliant age of Marlborough and Eugene, the balance of success inclined to the side of France; and Austria lost first Alsace, afterwards the Netherlands, and for a time Lombardy.

Towards
France.

The adjustments of territory by the general treaties of 1815 are certainly more favourable than any former arrangement to the maintenance of peace between France and Austria. By these treaties Austria definitively relinquished Belgium, which had so long been a ground of quarrel between the two countries; and Prussia became the power to which England and Holland look for co-operation in the event of war in the Netherlands. It was with this view that Prussia received an extension of ter-

Austria
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Autoch-
thones.

ritory on the Rhine, exactly as Lombardy and Venice were restored to Austria, in the understanding that the political guardianship of Italy should be committed to her care. In pursuance of this system, an Austrian army became the sole agent in reinstating the royal authority in Naples in 1820; and to the same power has been lately intrusted the task of preventing the spread of revolution in the States of the Church. Has Austria to apprehend that questions arising out of the politics of Italy will be of a nature to involve her with France? To this the only answer that can at present be given is, that the intermediate power (the court of Turin) has the strongest motives to prevent such collisions, and that the French people have never gone along with their rulers in desiring Lombardy as they desired Belgium.

Another and an equally interesting question is, what seem to be the comparative prospects of these rival states in regard to increase of resources? The country which shall most steadily cultivate the arts of peace and productive industry, will assuredly advance most effectually in its wealth and power. Since the overthrow of Buonaparte, and the general settlement of territory by the treaties of 1815, the Austrian government has evinced a decided tendency to peace, and a solicitude to heal the wounds inflicted by twenty years of war. Bosnia and Servia, detached from the central part of Turkey, and immediately adjoining the Austrian frontier, offered strong temptations; but the court of Vienna has declined to be a party to any plan for dismembering the Turkish empire. Let us hope that this abstinence from aggression has proceeded from enlightened views, and from a solicitude to promote improvement at home, by leaving capital and labour disposable for productive purposes. Of a disposition to that effect there have been several symptoms since the peace: export duties have been lowered; the assessment for the land-tax has been amended; several of the high roads from Germany to Italy have been improved; those in Bohemia have been extended; and several marshes, in particular an extensive one near Laybach, have been drained. These different undertakings are on a scale insignificant to the view of an Englishman, but important, as indicative of a disposition on the part of government to contribute to public works in a country where formerly their utility was not appreciated. No state, assuredly, would profit more largely by the extension of such works than Austria. Territory she possesses in abundance; her great requisites are, a more close connection, and a greater approach to uniformity in her different provinces. This can be accomplished only by extending the communications, by opening new roads and improving the old, as well as by excavating canals in situations where they are preferable to railways. The difficulty and expense attendant on such labours, great in almost every country, are particu-

larly so in mountainous regions like Spain, Switzerland, or the Alpine provinces of Austria; but in most parts of the empire the obstacles are lessened by the great extent of level ground.

The points of possible collision between Austria and Russia are on the side of Poland and Turkey. Were we to draw a parallel between these two empires, the results would be directly the reverse of those in the comparison with France; Russia being far more backward than Austria in national education, in manufactures, in the size of her towns, and in the average of individual property. Yet the vast extent of Russia, and the *éclat* she acquired by occasioning the overthrow of Buonaparte, has led the public, during the last twenty years, when comparing Russia and Austria, to regard the former as decidedly the greater power. On considering, however, the rigour of the Russian climate, the inconvenience of vast distances, and the general barbarism of the people, we cannot assent to this opinion without considerable qualification. In defensive war Russia is almost invincible, because her uncultivated provinces afford no resources to an invading force; but her financial means are not as yet greater than those of Austria, and the armies she has sent to a distance have been formidable only when subsidized by England. Russia has, however, one great advantage; a consciousness of the deficient education of her natives, and a readiness to accept the services of intelligent foreigners. How important would it be for Austria to call in similar aid, until her system of national education should be so far improved as to approach to that of France, England, and the north of Germany?

Prussia made common cause with Austria against France in 1792, but withdrew from the coalition as early as 1795; and during the subsequent invasions of the empire by the French, her government was considered a willing spectator of their success, calculated as it was to shake the influence of Austria over the Germanic body. But the grounds of such jealousy appear to have been removed by the arrangements of 1815, by which Prussia has the northern and Austria the southern portion of Germany under her influence. Though Prussia has long had the twofold advantage arising from the reformed religion and an enlightened government, she has no title to be placed on a level with Austria in point of resources. Her soil is in many parts so sandy and unproductive, that the average of her population, reckoned by the square mile, is less than that of the Austrian empire; while her revenue is only half, and her total population less than half, of that of her southern rival. The successes obtained by Prussia in the wars of the last century were owing chiefly to one cause, the talents of Frederick II.; and a recurrence of them ought not to be expected at any time when Austria shall be judiciously governed. (M. M.)

Austria
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Autocra-
tor.
Towards
Russia.

AUTOCHTHONES, an appellation assumed by some nations, importing that they sprung, or were produced, from the same soil which they still inhabited. In this sense *Autochthones* is nearly synonymous with *Aborigines*. The Athenians valued themselves on their being Autochthones, *self-born*, or *γηγενεις*, *earth-born*; it being the prevailing opinion among the ancients, that, in the beginning, the earth, by some prolific power, produced men, as it still does plants. The proper Autochthones were those primitive men who had no other parent beside the earth; but the name was also assumed by the descendants of these men, provided they never changed their ancient state, nor suffered other nations to mix with them. In this sense it was that the Greeks, and especially the Athenians, pre-

tended to be Autochthones, and, as a badge of this distinction, wore a golden grasshopper woven in their hair, an insect supposed to have the same origin.

AUTOCRATOR, a person vested with an absolute independent power, by which he is rendered unaccountable to any other for his actions. The power of the Athenian generals or commanders was usually limited; so that, at the expiration of their office, they were liable to render an account of their administration. But, on some extraordinary occasions, they were exempted from this restraint, and sent with a full and uncontrollable authority; in which sense they were styled *Αυτοκρατορες*. The same people also applied the name to some of their ambassadors, who were vested with a full power of determining matters according

Auto da fe to their own discretion. These were denominated *Προβεις* *Αυτοδατορες*, and resembled our plenipotentiaries.

Autumn.

AUTO DA FE, act of faith. See ACT OF FAITH.

AUTODIDACTUS, a self-taught scholar.

AUTOGRAPH denotes a person's own handwriting, or the original manuscript of any book, &c.

AUTOLITHOTOMUS, he who cuts himself for the stone. Of this a very extraordinary instance is given by Reiselius, in the Ephemerides of the Academy *Naturæ Curiosorum*, dec. 1, an. 3, obs. 192.

AUTOMATON (from *αυτος*, *ipse*, and *μαχαι*, *excitor*), a self-moving machine, or one so constructed, by means of weights, levers, pulleys, and other mechanism, as to move for a considerable time as if endowed with animal life. According to this description, clocks, watches, and all machines of that kind, are automata.

Under the article ANDROIDES, it was observed that the highest perfection to which automata could be carried was to imitate exactly the motions and actions of living creatures, especially of mankind, which are with more difficulty imitated than those of other animals. Very surprising imitations, however, have been made of other creatures. So long ago as 400 years before Christ, Archytas of Tarentum is said to have made a wooden pigeon that could fly; nor will this appear at all incredible, when we consider the flute-player made by M. Vaucanson, and the chess-player made by M. Kempel. Dr Hooke is also said to have made the model of a flying chariot, capable of supporting itself in the air. But M. Vaucanson above mentioned distinguished himself still more eminently. That gentleman, encouraged by the favourable reception of his flute-player, made a duck, which was capable of eating, drinking, and imitating exactly the natural voice of that fowl. Nay, what is still more surprising, the food it swallowed was evacuated in a digested state; not that it was really in a state of natural excrement, but only considerably altered from what it was when swallowed; and this digestion was performed on the principle of solution, not of trituration. The wings, viscera, and bones, of this artificial duck, were also formed so as very strongly to resemble those of a living animal. Even in the actions of eating and drinking this resemblance was preserved; the artificial duck swallowed with avidity and with quick motions of the head and throat, and likewise muddled the water with its bill, exactly like a natural one. See ANDROIDES.

AUTONOMIA, a power of living or being governed by our own laws and magistrates. The liberty of the cities under the faith and protection of the Romans consisted in their autonomia; that is, they were allowed to make their own laws, and elect their own magistrates, by whom justice was to be administered, and not by Roman presidents or judges, as was done in other places which were not indulged with the autonomia.

AUTOPYROS, from *αυτος*, and *πυρος*, wheat; in the ancient diet, an epithet given to a species of bread, wherein the whole substance of the wheat was retained, without retrenching any part of the bran. Galen describes it otherwise, viz. as bread where only the coarser bran was taken out; and thus it was a medium between the finest bread, called *similagineus*, and the coarsest, called *furfuraceus*. This was also called *autopyrites* and *syncomistus*.

AUTUMN, the third season of the year, when the harvest and fruits are gathered in. Autumn is represented in painting by a man at perfect age, clothed like the vernal, and likewise girded with a starry girdle, holding in one hand a pair of scales equally poised, with a globe in each, and in the other a bunch of divers fruits and grapes. His age denotes the perfection of this season; and the balance that sign of the zodiac which the sun enters when our autumn begins.

Autumn begins on the day when the sun's meridian distance from the zenith, being on the decrease, is a mean between the greatest and the least, which in these countries is supposed to happen when the sun enters Libra. Its end coincides with the beginning of winter. Several nations computed the years by autumns; the English Saxons, by winters. Tacitus tells us that the ancient Germans were acquainted with all the other seasons of the year, but had no notion of autumn. Lidyat observes of the beginning of the several seasons of the year, that

Dat Clemens hyemem, dat Petrus ver cathedratus,
Æstuat Urbanus, autumnat Bartholomæus.

Autumn has been reputed an unhealthy season. Tertulian calls it *tentator valetudinum*; and the satirist speaks of it in the same light: *Autumnus Libitinæ questus acerbæ*.

AUTUMNAL EQUINOX, that time when the sun enters the autumnal point.

AUTUMNAL POINT is that part of the equinox from which the sun begins to descend towards the south pole.

AUTUMNAL SIGNS, in *Astronomy*, are the signs Libra, Scorpio, and Sagittarius, through which the sun passes during the autumn.

AUTUN, one of the arrondissements of the department of the Saône and Loire, in France, extending over 647 square miles, or 414,080 acres. It is divided into eight cantons, and again into 87 communes, and contains 69,192 inhabitants. The chief city of the arrondissement bears the same name. It is built on the banks of the river Arroux, and contains 9310 inhabitants. During the revolution there was at Autun a vast foundery for cannon, and manufactories for other arms. At present the chief industry exercised consists in making cotton goods, hosiery, tanning, and paper mills. There are many Roman antiquities in the neighbourhood. Long. 4. 11. 50. E. Lat. 46. 56. 58. N.

AUVERNAS, a very deep-coloured heady wine, made of black raisins so called, which are produced near Orleans. It is not fit to be drunk before it is above a year old, but if kept two or three years it becomes excellent.

AUXERRE, an arrondissement in the department of the Yonne, in France. Its extent is 774 square miles, or 475,360 acres, divided into 12 cantons and 130 communes, with 102,122 inhabitants. The chief city of the arrondissement is of the same name. It is situated on the banks of the Yonne, in a district productive of wine; and is built in an antique fashion, with an ancient cathedral and a splendid palace. The inhabitants are 12,084, who, besides their trade in wine and in fire-wood, carry on manufactories of cloths, druggets, serges, cotton and woollen stockings, and some considerable tanneries. Long. 3. 28. 16. E. Lat. 47. 47. 54. N.

AUXESIS, in *Mythology*, a goddess worshipped by the inhabitants of Ægina, and mentioned by Herodotus and Pausanias.

AUXESIS, in *Rhetoric*, a figure whereby any thing is magnified too much.

AUXILIARY, whatever is aiding or helping to another.

AUXILIARY VERBS, in *Grammar*, are such as help to form or conjugate others; that is, are prefixed to them, to form or denote the modes or tenses thereof; as, *to have* and *to be* in the English; *être* and *avoir* in the French; *ho* and *sono* in the Italian, &c. In the English language the auxiliary verb *am* supplies the want of passive verbs.

AUXO, in *Mythology*, the name of one of two Graces worshipped by the Athenians. See HEGEMONE.

AUXONNE, a city in the arrondissement of Dijon and department of Côte d'Or, in France. It is on the Saône, and is strongly fortified. The inhabitants are 5280, who, besides their manufactures of cloth and serges, carry on by the river considerable traffic with Lyons. Long. 5. 17. 4. E. Lat. 47. 11. 24. N.

Autumnal
Equinox
Auxonne.

A V A.

Ava.

AVA. This extensive country is situated in the south-east of Asia, in the region beyond the Ganges. It is possessed by the Burmese, the limits of whose dominions, having been greatly enlarged by conquest, cannot be very correctly defined. On the west, where they border with the British territories in India, they are bounded by the province of Arracan, surrendered to the British by the treaty concluded with the Burmese in 1826, and by the petty states of Cassay or Kathé, and Assam, from which countries they are separated by lofty ridges of mountains; on the south by the Indian Ocean and the Siamese territories; on the north and north-east by the Chinese province of Yunan; and on the east by the independent and Siamese portion of Lao. The real extent of this country has not been ascertained by Europeans; and Mr Craufurd, who resided as ambassador at the court of Ava, and to whom we are indebted for the most recent information concerning it, states that he has nothing better to offer than conjecture on this important subject. The extreme western limits he describes as extending to the 93d degree of east longitude, and the eastern limits to 98° 40'. The southern limits are in lat. 15° 45' N., and to the north they probably extend to between the 26th and 27th degree. The Burmese territories may therefore be estimated at an extent in breadth of about 350 miles, and in length of nearly 700. The area of the country is conjectured by Mr Craufurd to contain 184,000 square miles. That portion of the kingdom which is farthest removed from the capital is divided into provinces or viceroyalties; but we have no information respecting their number or extent, or the power of their several rulers. Another and a more common division is into Myos or townships, of which, according to the statements of the natives, 4600 are contained within the limits of the Burmese empire; but they are so much addicted to exaggeration, that little reliance can be placed on this estimate. The number of townships has accordingly been reduced to 163, and the villages are reckoned to amount to 1300. But even this statement is founded chiefly on conjecture.

Aspect of the country.

That portion of Asia in which Ava is situated slopes from the central mountains towards the south; and as it approaches the Indian Ocean, it subsides into an extensive champaign country, which is overflowed in the rainy season by the swelling of the rivers. The Burmese territory is watered by four great streams, namely, the Irrawaddy; the Setang, sometimes called the Lokiang; the Saluem, called also the Pegu; and the Kyen-dwen, a tributary of the Irrawaddy. The first three of these rivers have their sources in the northern chain of mountains in the interior, some of which are covered with perpetual snow; and they run with a northerly course to the Indian Ocean. The Irrawaddy and the Saluem are the largest, and they intersect the Burmese country, which they overflow during the season of the rains. The delta of the Irrawaddy extends about 150 miles from the sea, to 17½ degrees of N. lat.; and this tract of country is low and champaign, intersected everywhere, during the overflow of the rivers, by canals and branches from the main stream. Eastward, where the Saluem enters the ocean, in the Gulf of Martaban, the country is of the same character; but it is not so extensively overflowed, owing to the inferior size of the latter stream. The tract along the sea-coast is the only low-lying portion of the Burmese territories. From this point the country begins to rise, and thence for about 300 miles farther it may be considered hilly and elevated;

and beyond this it is wild and mountainous. To the west and north-west it is divided from Arracan, Cassay, and Assam, by mountainous ridges often of great elevation. The country of Ava may therefore be distinguished into four divisions, namely, 1st, the great alluvial plain at the mouth of the Irrawaddy, the Setang, and the Saluem rivers; 2dly, the upland country, which commences about 150 miles from the shores; 3dly, the external mountainous regions towards the north, where are the sources of the great rivers; and, 4thly, the hilly regions, which form the western boundaries of the valleys of the Irrawaddy and the Kyen-dwen. The tract of sea-coast extends along the Indian Ocean about 240 miles, from Cape Negrais to the new British settlement of Amherst, near Martaban, and at the mouth of the river Saluem. All this coast is low, marshy, and broken by at least twenty channels of rivers or arms of the sea; but these being exposed without protection to the surf from the ocean, are choked by sandbanks, and cannot be entered by any vessel of burden. Hence there are only on the coast the three harbours of Martaban, Rangoon, and Bassein.

The alluvial division of Ava has a rich and fruitful soil; Natural and the upland country is also productive, though inferior productions. in fertility to the low-lying tracts. Its productions consist of rice, maize, millet, wheat, various pulses, palms, the sugar-cane, tobacco, cotton, and indigo. Rice is the great staple of agriculture throughout the kingdom, both in the upper and the lower provinces; and in the latter maize is cultivated to a considerable extent. Wheat, which would not thrive in the hot climate of the lower plains, is grown in the neighbourhood of the capital, and, considering its excellent quality, might be an important article of exportation. But it has long been the policy of the government, in which there is little prospect of any change, rigidly to prohibit the exportation of every species of grain. Bread is besides not the favourite food of the people, and the cultivation of wheat is consequently not encouraged. The sugar-cane appears to have been long known to the Burmese; but though the climate and soil are extremely favourable, it is not generally cultivated, and the art of manufacturing sugar is scarcely known. This is partly owing to a tyrannical edict of the government, prohibiting the exportation of this article, which might otherwise have been abundantly produced, and have become a valuable article of trade. A cheap and coarse sugar is obtained from the wine of the palmyra, which abounds in the upper provinces, especially in the arid country, for about 200 miles south of the capital, where numerous groves of this tree are to be seen. The cocoa and areca palms are not common. The tea plant is cultivated in the hills by some of the mountain tribes at the distance of about five days' journey, and by others in still greater perfection at the distance of about ten days' journey, from Ava. The leaves are elliptic, oblong, and serrated, and there is little doubt of its being the genuine tea plant of China. It is singular, however, that they never infuse it as they do the Chinese tea, but eat the leaf prepared with oil and garlic. Cotton is grown in every part of the country and its dependencies, but chiefly in the dry lands and climate of the upper provinces. Indigo is an indigenous product, and is universally cultivated, but in a very rude manner; and it is still more rudely manufactured, so that it is wholly unfit for exportation.

In the cultivation of fruits the Burmese are careless and unskilful. The most common fruits are the mango, the

Ava.

Ava. orange, the pine, the custard apple, the jack, the papaya fig, and the plantain. Most of these fruits grow spontaneously in the congenial soil and climate of the country. They are generally of indifferent quality, especially those which require care in the cultivation. The durian and the mangostin are found no farther north than Tavoy, in the latitude of 14 degrees. In horticulture and gardening the ignorance of the Burmese is still more remarkable. Though green vegetables and fruits form a great portion of their diet, they are at no pains to cultivate them, but are content with gathering those which grow spontaneously in the forests and marshes, such as the young shoots of the bamboo, wild asparagus, the succulent stems of a variety of aquatic plants, and other shrubs which would not be deemed fit for food in any other country. They are strangers to all the ordinary garden vegetables, such as peas, carrots, cabbages, turnips, mustard, cresses, radishes, &c. Even melons, cucumbers, and the egg-plant, so generally cultivated in India, are here little attended to. In the upper provinces the yam and the sweet potato are cultivated, but not extensively; and the common potato is unknown. Onions are produced in some of the upper provinces; and capsicum, which, after salt, is the most ordinary condiment used by the Burmese, is cultivated everywhere.

The forests of Ava abound in the finest trees. Of these the teak holds a conspicuous place, and the forests of this tree in Ava are the most extensive in India. The soil in the alluvial lands within the reach of the tides is not favourable to its growth, but it thrives in all the high grounds. The finest teak forest is that of Sarawaddy, which furnishes nearly all that is exported to other countries. Other extensive forests of teak exist in the provinces, and Ava the capital is supplied from a place distant fifteen days' journey. Almost every other description of timber known in India is produced in the Burmese forests.¹ The soondry, so much esteemed in Hindostan for the toughness and hardness of its wood, grows in abundance and of a large size within the influence of the tides. The bamboo also grows to an extraordinary size; its circumference is occasionally 23 or 24 inches. Varnish is another useful product of Ava, which is used by the Shans and the Burmese in their manufacture of lacquer ware. Stick-lack of an excellent quality is obtained in the woods.

Minerals. Ava is rich in minerals, producing gold, silver, copper, tin, lead, antimony, amber, coal, petroleum, nitre, natron, salt, limestone, and marble, noble serpentine or green stone, and precious stones. Gold, carried down from the higher grounds by the mountain streams, is found in the sands of different rivers: it is also found near the town of Pegu, and more abundantly in Lao. It is not plentiful, however, in the Burmese territories, and is imported from China. Silver mines are wrought in the country of Lao, towards the Chinese frontier, at a place called Bor-twang, about twelve days' journey from B'hamo, which is 250 miles north by east from Ava. Those mines are let at a rent of L.4800 per annum, to the Chinese, who among their semi-barbarous neighbours the Tonquinese, Siamese, Malays, and Burmans, generally engross every branch of industry which requires either ingenuity or capital. The mountainous districts of Lao in the east contain all the other metals, but such is the rude state of the people, that they neglect those natural advantages; and it is doubtful whether the copper, tin, and lead ores which are seen in the market of Ava are produced in the Burmese territories, or are imported from China. Iron is found abundantly in the eastern country of Lao, and it is wrought, though with

little advantage. Owing to ignorance and the want of proper machinery, about 30 or 40 per cent. of the metal is lost in the process of forging. The province of Martaban, and the mountains near the capital, contain lime in great abundance and of remarkable whiteness; and statuary marble, equal to the best Italian specimens, is found about 40 miles from Ava, on the eastern bank of the Irrawaddy. Mines of amber are wrought, and their produce must be abundant, judging from the price of this article, which at Ava does not exceed four shillings per pound. Nitre, natron, and salt, are found in the neighbourhood of the capital, and in the upper provinces; also traces of coal; and there is little doubt that this mineral is extensively diffused. It has not, however, been extracted from the earth by the ignorant and lazy inhabitants, who are content to use in its stead wood, which is scarce and dear. Petroleum, which is used by all ranks among the Burmese for burning in lamps, and also for smearing wood as a preservative against insects, is found near the village of Re-nan-gyaong, on the banks of the Irrawaddy. Here are about eight or ten pits or wells, the general depth of which is from 210 to 240 feet; some of them are deeper, and one is sunk to the depth of 300 feet. The shaft is of a square form, about three feet in diameter, and is formed by sinking a wooden frame. The liquid appears to boil up from the bottom like an abundant spring, and is extracted in buckets, and sent to all quarters of the country. In those parts where its price is raised by a long land-carriage until it comes into competition with Sesamum oil, the latter is preferred. This useful article is sold at the wells at from 5d. to 7d. per cwt., not above the 100th part of the price of whale oil, the cheapest article of the kind which can be procured in this country: at a greater distance its price rises to 3s. 4d. and 4s. 4d. per cwt., which is still a remarkably low price for the quantity of light which would be afforded by a hundredweight of this oil. The produce of these springs pays a tax of one twentieth; the annual amount of this tax, according to the collector or farmer, is 25,000 ticals, or L.2500 per annum. He calculates that he loses L.800 annually by smuggling, which would make the total produce of the tax L.3300 per annum, and the annual value of the whole produce of the wells L.66,000. Captain Cox was informed that there were 180 wells at one place, and at 4 or 5 miles distance 340 more. These wells belong to the owners of the soil: they are highly valued, yielding a sure rent, and are handed down from father to son as a valuable property. The expense of sinking a well is estimated by Cox at 2500 rupees, and the annual produce at the half of that sum.²

The precious stones which are produced in the Burmese territories are chiefly of the sapphire species and the spinelle ruby. They are found at two places, about five days' journey in a south-east direction from the capital, in the beds of rivulets or small brooks, from which they are separated by washing. The varieties of these stones are the oriental sapphire, the oriental ruby, the opalescent ruby, the star ruby, the green, the yellow, and the white sapphires, and the oriental amethyst. The common sapphire is by far the most frequently found. The crown, as in all despotic countries, lays claim to the produce of these rivers; and all the stones that exceed the value of L.10 are accordingly sent to the treasury. No stranger, not even Chinese or Mahomedan, is ever permitted to approach the spots where these precious stones are found. Noble serpentine or green stone is found in these mountains, and is exported in considerable quantities to China, where it is used for rings and amulets.

¹ Symes's *Embassy to Ava*.
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² *Journal of a Residence in the Burmese Empire*, by Captain Hiram Cox.

Ava.
Animals.

The country of the Burmese, abounding in deserts and forests, affords extensive shelter to the wild animals. The elephant, and the rhinoceros with a single horn, are found in all the deep forests of the country, and especially in Pegu. The royal tiger, the spotted leopard, and several species of wild cats, also the civet cat, are numerous in all the southern provinces. The hog is found in the wild parts of the country, and several species of deer, such as the Indian roe and the stag. Oxen and buffaloes are natives of the Burman forests; but no species of antelope is seen, and none of the canine tribe. There are, it is said, neither wolves, jackals, foxes, nor hyenas, in any of the tropical countries east of Bengal. The horse is known in the high lands, but not in the lower country of Pegu.

Of birds, the wild cock is common, and is seen in coveys in all the forests of the country. Two species of pheasants not known to the naturalists of Europe are numerous in Pegu; they are of a small size, and inferior in beauty of plumage to the pheasants of China and Nepal. There are peacocks, partridges, and quails, and in marshy places snipes; also geese and ducks in the upper provinces, and ducks in the alluvial plains.

The domestic animals of the Burmese are the ox, the buffalo, the horse, and the elephant. The oxen are used in the upper country, and the buffaloes in the low lands. They are of a good description, and, ranging in the luxuriant pastures of the plains, they commonly appear in high order. The care of these animals is all that is attended to in the rural economy of the Burmese. The buffalo is confined to agricultural labour, and the ox alone is used as a beast of burden or of draught. The Burman horses are rarely more than thirteen hands high; the full-sized horse being unknown in the tropical countries of Asia east of Bengal. Horses are never used but for riding, and only in the upper country, there being no footing for a horse in the alluvial districts. The elephant is not used by the Burmese, except perhaps in the eastern country of Lao, as a domestic animal. He is not employed as a beast of burden, and seems to be maintained merely for royal luxury and ostentation. About 1000 elephants are kept for the pleasure of the king, some of them of fine quality, and of a white colour. The hog is a domestic animal, but of the most filthy and disgusting habits. The dog, as in most other parts of the East, is neglected, and is seen prowling about the streets a prey to disease and famine. Cats are numerous; and about the capital a few goats and sheep, of a puny race, are kept more for curiosity than for use. A few asses are also seen, which are brought from China. The camel is not known even in the upper country, where he would be found extremely useful.—Of poultry only a few common fowls and ducks are reared, for the purpose of being, it is said, clandestinely sold to the Chinese, and to Christian and Mahomedan settlers.

Popula-
tion.

The extensive country which has been conquered by the Burmese contains many distinct tribes and nations, who, though they differ in language, and often in manners, customs, and religion, appear, from their resemblance in features and form, to be the same race with the inhabitants of the countries that lie between Hindostan and China. The most considerable of these tribes are the proper Burmans, the Peguans or Talains, the Shans or people of Lao, the Cassay or Kathé, the Zubaing, the Karens, the Kyens, the Yo, and the Laira. They may be generally described as of a stout, short, active, but well-proportioned form; of a brown but never of an intensely black complexion, with black, coarse, lank, and abundant hair, and a little

more beard than is possessed by the same races to the south, namely, the Siamese and the people of Lao. Nor does the climate appear sensibly to affect their physical appearance; the inhabitants of the low and marshy plains being rather of a larger make, and more athletic, than those who dwell in the upper country. The population of the country has been variously estimated and grossly exaggerated by the ignorance of Europeans, who have raised it to 17,000,000, 19,000,000, and even 33,000,000. There is no enumeration of the inhabitants in any part. Mr Craufurd, on the best data that he could procure, estimates them at 2,414,000, which is probably above rather than under the truth.

The Burmans appear to be inferior to the Hindoos, and still more to the Chinese, in arts, manufactures, and industry, and in all the institutions of civil life. Their government is a pure despotism, the king dispensing torture, imprisonment, or death, according to his sovereign discretion. One of his customary titles is lord of the life and property of all his subjects; and they frequently find to their cost that this is no vain title. The chief object of government seems to be the personal honour and aggrandizement of the monarch; and the only restraint on the exercise of his prerogative is the fear of an insurrection. He is assisted in his administration by a public and a privy council, through which all orders are issued, and by a majority of whom all public matters are decided. Every royal edict must be sanctioned by this council; and each member is a judge, and, besides, exercises an appellate jurisdiction in the last resort. All questions, before they are submitted to the public advisers of his majesty, are debated in the privy council, which consists of four officers, and to which are attached four deputies, thirty secretaries, and five other officers, who carry messages, and report from time to time the proceedings of the council to the king, and who are in reality privileged spies. The paymaster-general is an officer of high importance; and there are other officers of distinction, such as the daywoon or king's armour-bearer, and the master of the elephants, though they bear no share in the administration of public affairs.¹ The king may order any of those great officers to be punished at his pleasure; and Mr Craufurd mentions, that, during his residence at Ava, the favourite minister, on a complaint from some of the women of the court, was, by an order from the king, seized by the public executioner, and laid at the side of the road for two hours under the burning sun, with a weight upon his breast; and, after undergoing this disgraceful punishment, he continued to discharge his high functions as before. The country at large is ruled by provincial governors; and it is divided into provinces, townships, districts, villages, and hamlets. The governor is vested with the civil, military, judicial, and fiscal administration of the province. He is assisted by a deputy, who is a judge, and exercises the power of life and death, though in all civil cases an appeal lies from his sentence to the chief council at the capital; and also by a collector of taxes, and another of customs. In all these courts there is an officer who acts as a kind of sheriff or principal conservator of the peace, another officer who acts as public informer, and a third as assessor to the chief judge. To each court is attached a proper complement of messengers; and the executioner is always present, along (as Mr Craufurd adds) with his "band of branded ruffians." There are in all the townships and villages judges with a subordinate jurisdiction. The three towns composing the ca-

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¹ Symes's *Embassy to Ava*, chap. xiii. The members of the public council are called Wun-gyis, or the bearers of the great burden; of the privy council, Atwen-wun; the deputies, Wun-dank, i. e. a prop; the privy council is called Lut-d'hau.

Ava. pital have each a governor, and they are assisted by a sort of head constables, who are known to all strangers "as the busy, corrupt, and mischievous agents of the local authorities." But from a mere dry detail of the provincial administration and judicial institutions of the Burmese, their extreme inefficiency can scarcely be known. No Burmese officer ever receives a fixed salary. He is paid by an assignment either of land or of the labour and industry of a given portion of the inhabitants, and the inferior magistrates by fees, perquisites, and other emoluments; and hence the most shameful extortion and bribery prevails amongst all the functionaries of the Burmese government, from the highest to the lowest. Justice is openly set to sale; and the exercise of the judicial functions is found to be so lucrative, that the two executive councils have by their encroachments deprived the regular judge of the greater part of his employment. So notoriously corrupt are all the judges among the Burmese, that a lawsuit is considered by all prudent men as a serious calamity.

The criminal code of the Burmese is barbarous and severe, and the punishments inflicted are shocking to humanity. Gang robbery, desertion from the king's service, robbing of temples, and sedition or treason, are considered the most heinous crimes, and are most severely punished, the criminal being in some cases embowelled, or thrown to wild beasts. In these cases they generally meet death with Asiatic indifference; and it is related of one woman who was adjudged to the latter punishment, that she deliberately crept into the cage of the tiger, and making an obeisance to the animal, was immediately killed by a single blow of his fore-paw, and dragged into the inner recesses of his den. For lesser offences, fines, whipping, and imprisonment are the punishments adjudged. In important cases torture is applied both to the principals and witnesses; and the jailers often torture their prisoners in order to extort money from them. The English and Americans who, during the late war, were thrown into prison, were frequently tortured, and were compelled to pay fines to the jailer in order to procure milder treatment. The trial by ordeal is sometimes resorted to, as well as other superstitious modes of procedure, which denote the lowest state of barbarism. But the administration of justice among the Burmese, however vexatious and expensive, is far from efficient; and the police is as bad as can possibly be conceived. Hence the country is overrun with pirates and robbers, and a general laxity, negligence, and corruption, pervade every branch of the internal administration.

Among the Burmese, society is distinguished into seven classes, who have each peculiar privileges. These are the royal family, the public officers, the priesthood, the rich men, the cultivators and labourers, slaves and outcasts. There are no hereditary honours under the Burmese government, as all the public functionaries may be dismissed from their offices, and deprived of their rank, at the caprice of the sovereign. Any subject, with the exception of a slave or outcast, may, however, aspire to the first offices in the state, to which, in reality, persons of very mean origin do frequently attain. The Burmese are extremely punctilious and strict in maintaining the various orders and distinctions of society. The great officers of government hold the first rank after the king and the princes of the blood, and they are distinguished by a chain or badge, which is the order of nobility, and of which there are different degrees, distinguished by the number of strings or small chains which compose the ornament. Three of open chain-work mark the lowest rank; three of neatly-twisted wire the next; there are then six, nine, twelve, and finally twenty-four, which the king alone

is entitled to wear. But every article possessed by a Burman for use or ornament,—his ear-rings, cap of ceremony, horse furniture,—the metal of his spitting cup or drinking cup, if it be of gold or any other metal,—the colour and quality of his umbrella, an article in general use, and one of the principal insignia of rank, whether it be of brown varnished paper, red, green, gilded, or plain white, the royal colour,—all indicate the rank of the person; and if any of the lower orders usurp the insignia of a higher class, he may be slain with impunity by the first person who meets him; and so prevalent is the aristocratical spirit of the higher orders, that such an usurpation would be sure to meet punishment.

When a merchant acquires property, he is registered by a royal edict under the name *Thuthé*, or "rich man," which gives him a title to the protection of the court, while it exposes him also to regular extortion. The priesthood form a separate order, who are interdicted from all other employment, and are supported by voluntary contributions. They are distinguished by the yellow colours in their dress, which it would be reckoned sacrilege in any other person to wear; and a formal complaint was made, during the conferences with the British previous to peace, because some of their camp followers were seen dressed in yellow clothes. There is also an order of nuns or priestesses, who make a vow of chastity, but may at any time quit their order. The free labouring population consist of proprietors or common labourers; and they are all considered the slaves of the king, who may at all times call for their services as soldiers, artisans, or common labourers. Hence a Burman, being the property of the king, can never quit the country without his especial permission, which is only granted for a limited time, and never to women on any pretence. The British and others who had children by Burmese women while they resided in the country experienced the greatest difficulty, even with the aid of heavy *douceurs*, in taking them along with them. There are two classes of slaves; namely, those who have mortgaged their services for a debt, and who are used as slaves until the debt is paid; and prisoners of war, who are always reduced to slavery. The class of outcasts consists of the slaves of the pagodas, the burners of the dead, the jailers and executioners, who are generally condemned criminals, lepers and other incurables, who are held in great abhorrence, and treated with singular caprice and cruelty. They are condemned to dwell alone, and in a state of disgrace; and any man who is infected with this disease, however high his rank, is forced, by continual bribes to the officers of justice, to purchase an exemption from the penalties which attach to him. Prostitutes are also considered as outcasts, but not women of loose character, chastity not being in any repute among the Burmans. The women in Ava are not shut up as in many other parts of the East, and excluded from the sight of men: on the contrary, they are suffered to appear openly in society as in Europe. In many other respects, however, they are exposed to the most degrading treatment. They are sold for a time to strangers; and the practice is not considered shameful, nor the female in any respect dishonoured. They are seldom unfaithful to their new master; and many of them have proved essentially useful to strangers in the Burmese dominions, being generally of industrious and domestic habits, and not addicted to vice.

The taxes from which the public revenue arises are in Finance general rude and ill-contrived expedients for extortion, and taxes. and are vexatious to the people at the same time that they are not productive to the state. One of the most common is a house-tax on the cultivation of the soil. Nearly all the cultivated land of the kingdom is assign-

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ed to favourites of the court or to public functionaries in lieu of stipends or salaries, or is appropriated to the expenses of public establishments, such as war-boats, elephants, &c.; and this assignment conveys a right to tax the inhabitants according to the discretion of the assignee. The court favourites who receive these grants generally appoint agents to manage this estate; they pay a certain tax or quit-rent to the crown, and their agents extort from the cultivators as much more as they can by every mode of oppression, often by torture. Besides this stated tax, extraordinary contributions are levied by the council of the state immediately from the lords and nobles to whom the lands are assigned, who in their turn levy it from the cultivators, and generally make it a pretence for plunder and extortion. It is the Burmans and Talains, the most improved class of the population, who pay this tax. They may, besides, be called on to labour in the public works. The Karyens, a ruder class, who cultivate the lands, are subjected to a regular capitation, and are in consequence exempted from the occasional *corvées* to which the others are exposed. Taxes are also laid on fruit trees, on the teak forests, on the petroleum springs, on mines of gold and precious stones, on the fishery of ponds, lakes, rivers, and salt-water creeks, on the manufacture of salt, on the eggs of the green turtle, and on esculent swallows' nests. The custom duties amount on all imports to 10 per cent., and on exports to 5, besides 2 per cent. on the former and 1 per cent. on the latter to the local officers. European and other square-rigged vessels are, besides, subjected to a long list of heavy and vexatious charges; and until within a few years they were obliged to unship their rudders, and to land their guns. These oppressions were done away by the treaty concluded between the British and Burmese in 1826. There are no transit duties, nor any duties at fairs or markets; and as the consumption of wines, spirits, opium, and other intoxicating drugs, is forbidden by law, they cannot of course be subject to any tax.

Manufactures and commerce.

In the useful arts the Burmese have not made any great advances. The whole process of the cotton manufacture is performed by women, who use a very rude species of loom, and are much inferior in dexterity to the Indian artisans. No fine linen is ever manufactured at home; and the home manufacturer, even in the interior of the country, cannot withstand the competition of British cotton goods. Silk cloths are manufactured at different places; the finest at Ava or Amarapura, from raw Chinese silk, and the coarsest at She-daong, from the raw material of Pegu. The Burman manufactures of silk are generally coarse, high-priced, and durable. The common coarse unglazed earthenware, which is manufactured in Ava, is of an excellent quality; and a better description of pottery is also made. They are entirely ignorant of the art of making porcelain, which is imported from China. Iron ore, as already mentioned, is smelted; but the Burmans cannot manufacture steel, which is brought from Bengal. Coarse articles of cutlery, including swords, spears, knives, also muskets and matchlocks, scissors, and carpenters' tools, are manufactured at Ava. Brass wire is manufactured at Sagaing, the copper being procured from China, and the zinc from Lao. Gold and silver ornaments are manufactured in every considerable place in the country, but in a decidedly rude and clumsy manner. About forty miles from Ava, on the eastern bank of the Irrawaddy, is an entire hill of pure white marble. Here are sculptured marble images of Gautama or Buddha. The marble is of the finest quality; but the workmanship is rude, and displays neither taste nor fancy.

Considering the fertility of the country, and its natural advantages, the commerce of Ava is not extensive. It

has of late years, however, and especially since the relaxation of the East India Company's monopoly in 1814, considerably increased. The internal trade of the country centres chiefly in Ava, the capital, and the sea-ports of Rangoon, Tongo, and Bassein. The traders in those parts, and in the lower parts of Pegu, generally bring to the capital and upper provinces rice, pickled and dried fish, and foreign commodities imported from Bengal, the Asiatic Archipelago, and Europe. They receive in exchange petroleum, which, as already mentioned, is a great article of internal consumption; saltpetre, lime, paper, lacquer ware, cotton and silk fabrics, iron, cutlery, some brass ware, terra japonica, palm, sugar, onions, tamarinds, &c. &c. The Shans or people of Lao, from the east, import into Ava cotton and silk stuffs, some raw silk, varnish, stick-lack, ivory, bees-wax, lacquer ware, swords, gold, lead, and tin. They receive in return the articles of the lower country, which are chiefly salt, with pickled and dried fish. One of the most important branches of the trade of Ava is that carried on with the Chinese province of Yunan. The principal marts of this trade are Midé, six miles to the north-east of Ava; and B'hamo, the chief place of a province of the same name, bordering on China. It is carried on at annual fairs. The Chinese caravan, setting out from the western province of Yunan at the close of the periodical rains, generally arrives at Ava in the beginning of December, after a journey of six weeks over difficult and mountainous roads, on which only horses, mules, and asses can travel. No part of the journey is by water; from which it would appear that the upper streams of the Irrawaddy, near to the Chinese frontier, are not navigable. The principal fair is, however, held at B'hamo, comparatively few traders arriving at Ava. The articles imported from China are wrought copper; orpiment or yellow arsenic from the mines in Yunan, of a very fine quality, which finds its way into western Asia, and into Europe through Calcutta; quicksilver, vermilion, iron pans, brass wire, tin, lead, alum, silver, gold and gold-leaf; earthenware, paints, carpets, rhubarb, tea, honey, raw silk, velvets and other wrought silks; spirits, musk, verdigris, dry fruits, paper, fans, umbrellas, shoes, wearing apparel, and a few live animals, such as dogs, pheasants, and ducks. The metals are chiefly produced in the province of Yunan, which, though poor, is rich in minerals. The tea, which is coarse and black, is supposed to be from the same province, and is retailed at the rate of 6½d. a pound, though the price paid to the Chinese importer is not half that sum. The annual value of the raw silk, which is the chief article of import, is L.80,000 sterling. The articles sent to China consist of raw cotton to the amount of twenty millions of pounds yearly, and by far the most considerable article of export; feathers, chiefly of the blue jay, for ornamenting the dresses of ceremony of the Chinese mandarins, and which are so much valued that the bird is pursued by the Burmese hunters as far as the province of Cuttack in India; esculent swallows' nests, ivory, rhinoceros and deers' horns; sapphires, used for buttons to the caps of the Chinese officers of rank, and noble serpentine, with a small quantity of British woollens. The annual value of this trade is estimated to be from L.400,000 to L.700,000 sterling.

The foreign trade of Ava, carried on chiefly through the central part of Rangoon, is with Chittagong, Dacca, and Calcutta, in Bengal; Madras and Masulipatam on the Coromandel coast; the Nicobar islands and Penang; also occasionally with Bombay, and with the Persian and Arabian Gulf. The articles exported are teak wood, chiefly to Calcutta; terra japonica, stick-lack, bees-wax, elephants' teeth; raw cotton of a fine quality, from Ava to Dacca; gold and silver, especially from Bassein, and by the over-

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Ava. land route of Arracan, to the annual value of L.65,000. The principal imports are cotton piece goods, formerly furnished to the Burmese, who have no cotton manufactures, from the Coromandel coast. To these were afterwards added the cheaper fabrics of Bengal, and both are now in a great measure superseded by the British manufactures. The other imports are British woollens, iron, steel, quicksilver, copper, cordage, borax, sulphur, gunpowder, saltpetre, fire-arms, coarse porcelain, English glass-ware, opium, tobacco, cocoa and areca nuts, sugar, and spirits. Neither the areca nor the cocoa palms flourish in the Burmese territory; and their produce being in general use, is largely imported. The internal trade in the low country, where there are scarcely any roads, is carried on mostly by the rivers and canals; and the Irrawaddy is navigated by vessels of 100 tons burden. In the upper country goods are mostly conveyed in carts drawn by oxen or small horses; and the merchants, as in other parts of Asia, travel in caravans for security.

The progress and civilization of a country may be generally very accurately measured by the state of its currency; and that used by the Burmese is of the rudest description. For the smaller payments lead is employed; and for the larger payments gold or silver, but principally the latter. These are not coined into pieces of any known weight and fineness; and in every payment of any consequence the metal must be weighed and generally assayed, for which a premium is paid to the bankers or money-changers, of $2\frac{1}{2}$ per cent., besides one per cent. which they say is lost in the operation. These bankers are said by Symes to be workers in silver, and every merchant has one with whom he lodges his cash, and who receives on this account a commission of one per cent. The want of a more convenient currency must tend greatly to embarrass the operations of trade. The high interest received for money, which is 25 and 60 per cent. when no security is given, is another proof of the low state of commerce among the Burmese.

The Burmese, as may be supposed, are entirely ignorant of literature and science. Their astronomy and astrology they have borrowed from the Hindoos, and the Brahmins have still the exclusive care of such matters. According to their calendar, a common year consists of 12 months, of 29 and 30 days alternately; the year consequently is of 354 days; and, in order to preserve the solar time, the fourth month of every year is doubled, and the additional days and hours are supplied by the royal edicts as they are required. The natural day is divided into 60 parts, called Nari; and time is measured by means of a copper cup perforated at the bottom, and placed in a vase of water. This cup sinks to a particular mark at the termination of each part, when a great bell is struck, which is suspended from a tall belfry close to the palace. The Burmese are entirely ignorant of navigation, and in their voyages to Calcutta during the fine season, they creep along the coast, never losing sight of it. They are equally ignorant of geography and of all the kindred sciences, and, in lieu of useful knowledge, they cultivate the vain art of alchemy, labouring with intense anxiety to convert the baser metals into gold. Morality, as in most semi-barbarous states, is at a low ebb among them; and their rulers, according to the depositions of several Europeans, British and others, taken before Mr Craufurd at Rangoon, have no conception of the moral excellence or utility of good faith. "They would," says the Rev. Mr Judson, the respectable American missionary, "consider it nothing less than folly to keep a treaty if they could gain any thing by breaking it. The fidelity observed by the British government in fulfilling the stipulations of the late treaty stupefied the Burmans. They knew not what to make of it, but

some of them have now begun to admire it. I heard many make use of expressions like the following: 'These Kulas (English), though they drink spirits and slay cattle, and are ambitious and rapacious, have a regard for truth and their word which is quite extraordinary, whereas in us Burmese there is no truth.' The first circumstance in the conduct of the British which struck them with surprise, was the return of Dr Sandford on his parole; and next, Sir A. Campbell's returning six lacs of rupees offered him after the money was in his power."

Ava. The Burmese army is recruited from the whole male Military population of the country, who are at the absolute disposal of the king, for war or any other purpose; but there is no fixed plan for calling out this conscription, nor any limited period of service; and the inhabitants are far from being of a warlike character. The conscripts, when brought together, are a mere rabble, without discipline or valour. They are always dragged unwillingly into the service, and when an expedition was sent against Junk-seylon and the Siamese, they were seen by Europeans, who stated the fact to Mr Craufurd, embarked by hundreds with their hands and legs tied, as if they had been so many cattle. They were unable to withstand the attack of the European force, even though protected by stoccades; and they were completely dismayed by the resolution with which those new enemies advanced to close quarters, and by the destructive effects of their artillery, rockets, &c. From their success against all the neighbouring tribes with whom they had been engaged, they embarked in a war with the British in the vain confidence of an easy triumph; but the entire destruction of a corps of 1000 men at Rangoon, the subsequent assault of the Burman lines, and the retreat of the army to Donabew, entirely dissipated these hopes, and overwhelmed both the court and the people with astonishment and dismay. From the composition of the Burmese force, it cannot long be maintained in the field, and is sure to be entirely dispersed by a defeat; and accordingly, when the British army had advanced to within 45 miles of the capital, it was scarcely possible to collect 1000 men for its defence. The Burmese are very indifferently armed, with clumsy two-handed swords, spears, matchlocks, as many old European muskets as they can purchase, rude padereros of native manufacture, and a few old iron and brass cannon, purchased from strangers, and in no good condition; but they excel in the construction of field works, which they raise on the best positions, and with surprising celerity. Since the conquest of Cassay or Munipore the Burmese have maintained a body of cavalry, chiefly composed of the Cassay horsemen, who act as a body-guard to the king. They are provided with a spear about seven or eight feet long, which they manage with great dexterity. The peace establishment of the sovereign of Ava is very limited; and Symes mentions that he could never observe any assemblage of more than 2000 troops in the capital.

The Burmese are not votaries of Brahma, but sectaries of Religion. of Boodh, who is universally considered by the Hindoos as the ninth Avatar, or descent of the Deity in his capacity of preserver; and the rites, doctrines, and priesthood are nearly the same as in the countries to the east of the Ganges, namely, Siam, Camboja, and in Ceylon, and formerly in the Asiatic islands. Neither Christianity nor Mahomedanism has made any progress. Foreigners enjoy the most perfect religious toleration, and there is no hostility either to Europeans or to Christians, as in Mahomedan countries; but the Burmese rulers view any attempt to convert the natives to the Christian or any other foreign faith as an interference with their allegiance, and they discourage all such schemes. An American mission was settled

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there under the conduct of Mr Judson, who brought to the execution of this perilous service zeal and sound discretion; but it entirely failed of success, not from any bigotry on the part of the natives, but from the opposition of men in power. On the war breaking out with the British the missionaries were imprisoned, and narrowly escaped with their lives. They are now prosecuting their missionary labours in the British province of Martaban.

History.

The ancient history of Ava is very imperfectly known, and the sketch compiled by Mr Craufurd, from oral tradition, and from written documents which he procured during his residence in the country, consists chiefly of dynasties and kings; of which little more is given than the names. We learn from the Portuguese navigators, that, about the middle of the 16th century, four powerful states ruled over those countries which lie between the south-east province of British India, Yunan in China, and the Eastern Sea, namely, Arracan, Ava, Pegu, and Siam. By the help of the Portuguese the Burmans subdued the Peguers, and maintained their supremacy over them throughout the 17th and during the first 40 years of the 18th century, when the Peguers revolted, and a war ensued, in the course of which, by the aid of arms procured from Europeans, they gained several victories over the Burmans, and having taken their capital Ava, and made the king prisoner, they reduced the whole country to submission. Alompra, a man of low extraction, who had been left by the conqueror in charge of Monchaboo, an inconsiderable village, planned the deliverance of his country. He attacked the foreigners at first with small detachments; but when his forces increased, he suddenly advanced, and took possession of the capital in the autumn of 1753. In 1754 the Peguers, anxious to recover their lost conquests, sent an armament of war-boats against Ava; but after an obstinate and bloody battle they were totally defeated by Alompra. In the districts of Prome, Donabew, Loonzay, &c. the Burmans revolted, and succeeded either in expelling or putting to the sword all the Pegu garrisons in their towns. In 1754 Prome was besieged by the king of Pegu, when he was again defeated by Alompra in a severe battle, and the war was transferred from the upper provinces to the mouths of the navigable rivers, and the numerous creeks and canals which intersect the lower country. In 1755 Alompra defeated in a general battle Apporaza the king of Pegu's brother, after which the Peguers were driven from Bassein and the adjacent country, and were forced to withdraw to the fortress of Syriam. About the year 1754 Alompra, having subdued the Cassayers, who had revolted, laid siege to this fortress, which was taken by surprise, when the garrison were mostly put to the sword, and the Europeans were made prisoners. In these wars the French sided with the Peguers, the English with the Burmans. Monsieur Dupleix, the governor of Pondicherry, had sent two ships to the aid of the former; but the master of the first was decoyed up the river by Alompra, when his vessel was taken, and he along with his whole crew was massacred. The other escaped by being accidentally delayed, and carried accounts of this disaster to Pondicherry. Alompra was now master of all the navigable rivers; and the Peguers, being entirely shut out from foreign aid, were finally subdued. In 1755 the conqueror laid siege to the city of Pegu, which finally capitulated, on condition that the king should govern the country, but that he should do homage for his kingdom, and should also surrender his daughter to the victorious monarch. Alompra, with Asiatic perfidy, violated these conditions, and at last succeeded by treachery in obtaining possession of the town, which he abandoned to the fury of his soldiers. In 1757 the Peguers endeavoured to throw off the yoke, but they

were overthrown in a decisive engagement near Rangoon; and Alompra arriving soon after, quelled the rebellion. He afterwards reduced the town and district of Tavoy, and finally undertook the conquest of the Siamese. His army advanced to Mergui and Tennasserim, both which towns were taken; and he was besieging the capital of Siam when he was taken ill. He immediately ordered his army to retreat, in hopes of reaching his capital alive; but he expired before this, in 1760, in the 50th year of his age, after he had reigned eight years. He was succeeded by his oldest son Namdojee Praw, whose reign was disturbed by the rebellion of his brother Shembuan, and afterwards by one of his father's generals. By his vigour he succeeded in quelling these revolts; and he afterwards turned his arms against the refractory Peguers, who were reduced to subjection. He died in little more than three years, leaving one son in his infancy. On his decease the throne was usurped by his brother Shembuan, who never acknowledged the rightful heir. He was intent, like his predecessors, on the conquest of the adjacent states; and he accordingly made war in 1765 on the Munnipore Cassayers, and also on the Siamese, with partial success. In the following year he renewed the war with the latter, defeated the Siamese, and, after a long blockade, obtained possession of their capital. But while the Burmans were extending their conquests in this quarter, they were invaded by a Chinese army of 50,000 men from the province of Yunan. This army was hemmed in by the skill of the Burmans; and being harassed by the want of provisions, it was afterwards attacked and totally destroyed, with the exception of 2500 men, who were sent in fetters to work in the Burmese capital at their several trades. In the mean time the Siamese revolted from the Burmese yoke; and while the Burman army was marching against them, the Peguer soldiers who were embodied in it rose against their companions, and commencing an indiscriminate massacre, pursued the Burman army to the gates of Rangoon, which they besieged, but were unable to capture. In 1774 Shembuan was engaged in reducing the marauding tribes. He took the district and fort of Martaban from the revolted Peguers; and in the following year he sailed down the Irrawaddy with an army of 50,000 men, and, arriving at Rangoon, he put to death the aged monarch of Pegu, along with many of his nobles, who had shared with him in the guilt of rebellion. He died in 1776, after a reign of 12 years, during which he had extended the Burmese dominions on every side, having reduced to a state of vassalage the petty states in the neighbourhood, and the uncivilized tribes in the western hills, as well as those in the mountainous tracts to the east of the Irrawaddy. He was succeeded by his son, a youth of 18, who proved himself a blood-thirsty despot, and was put to death by his uncle Mindragee Praw in 1782, who ascended the vacant throne. In 1783 he sent a fleet of boats against Arracan, which was conquered, and the rajah and his family made prisoners. Cheduba, Ramnee, and the Broken Isles soon afterwards surrendered.

The Siamese who had revolted in 1771 were never afterwards subdued by the Burmans. They retained their dominion over the sea-coast, as far as Mergui; and in the year 1785 they attacked the island of Junkseylon with a fleet of boats and an army. But they were ultimately driven back with loss; and a second attempt by the Burman monarch, who in 1786 invaded Siam with an army of 30,000 men, was attended with no better success. In 1793 peace was concluded between these two powers, the Siamese yielding to the Burmans the entire possession of the coast of Tennasserim on the Indian Ocean, and the two important sea-ports of Mergui and Tavoy.

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In 1795 the Burmese were involved in a dispute with the British in India, in consequence of their troops to the amount of 5000 men entering the district of Chittagong in pursuit of three robbers who had fled from justice across the frontier. Explanations being made, and terms of accommodation offered by General Erskine, the commanding officer, the Burmese commander retired from the British territories, when the fugitives were restored, and all differences for the present amicably arranged.

But it was evident that the gradual extension of the British and Burmese territories would in time bring the two powers into collision, and would in all probability lead to a war between them. And it happened, accordingly, that the Burmese, having conquered the neighbouring states of Pegu, Siam, and Arracan, and the northern countries of Cassay and Assam, came into contact with the British frontier near Sylhet on the north-east, which was occupied by chiefs dependent, though somewhat loosely, on the British government. The Burmese leaders, arrested in this manner in their career of conquest, and flushed with past success, were impatient to measure their strength with their new neighbours. It appears from the evidence of Europeans who resided in Ava, that they were entirely unacquainted with the discipline and great military resources of the Europeans. They imagined that, like the other nations in the East, they would fall before their superior tactics and valour; and their cupidity was inflamed by the prospect of marching to Calcutta and of plundering the country. With such dispositions, it was not to be supposed that causes of quarrel would long be wanting; and accordingly, on the whole frontier line, the Burmese were continually committing petty acts of aggression, which the British troops would have been justified in repelling by force. At length their chiefs, throwing off the mask, ventured on the open violation of the British territories. They attacked a party of Sepoys within the frontier, seized and carried off British subjects, and at all points their troops, moving in large bodies, assumed the most menacing positions. The island of Shaparee, at the mouth of the Naaf river, had been occupied by a small guard of British troops. These were attacked on the 23d September 1823, during the night, by the Burmese, and driven from their post with the loss of several lives; and to the repeated demands of the British for redress no answer was returned. On the north-east frontier, in the district of Sylhet, the Burmese troops entered the territories of Cachar, which were under the protection of the British, in pursuit of certain alleged fugitives; and they proceeded, according to their custom, to fortify their posts by strong palisades. Here they were attacked in January 1824, and driven from their positions. Several other actions took place, in some of which the British were forced to fall back from the stoccaded posts of their enemies; and in May the Burmese invaded Chittagong in great force, and surrounded a British detachment under Captain Norton, which was almost entirely destroyed. The alarm which this disaster occasioned in the British territories was great, and extended as far as Calcutta.

Hostilities having now commenced, the British rulers in India, with their usual boldness and energy, resolved to carry the war into the enemy's country; and with this view an armament was fitted out under the orders of Commodore Grant and Sir Archibald Campbell, which entered the Irrawaddy river, and anchored off Rangoon on the 10th May 1824. After a feeble resistance this great sea-port of the Burmese surrendered, and the troops were landed. The place was entirely deserted by its inhabitants, the

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provisions were carried off or destroyed, and the invading force took possession of a complete solitude. The devastation of the country, which was part of the defensive system of the Burmese, was carried into execution with unrelenting rigour, and the invaders were soon reduced to great difficulties. Being destitute both of provisions and of the means of transport, they were confined within the limits of Rangoon, where they were soon surrounded on all sides by an overwhelming force, posted behind stoccaded entrenchments, which were constructed with equal celerity and skill. The flat country at the mouth of the Irrawaddy is extremely favourable for defence, being mostly covered with a thick and tenacious jungle, intersected by a few narrow and uncertain foot-paths, only known to the Karyan tribes, who cultivate the lands; or by numerous creeks and rivers, from whose thickly-wooded banks a destructive fire might be poured on the invading force. The unskilful Burmese did not, however, profit by the localities as they might have done for the defence of the country. They continued to erect their stoccade under cover of the jungle, and, gradually encroaching on the British position, to harass the outposts and foraging parties, and to prevent all communication between the invaders and the inhabitants. On the 28th May Sir A. Campbell ordered an attack to be made on some of the nearest posts of the enemy, which were all carried after a feeble defence. Another attack was made on the 10th June on the stoccades at the village of Kemmendine. Some of these, being too strong to be attacked by escalade, were battered by artillery; and the shot and shells struck such terror into the Burmese that they fled from their works in the utmost precipitation. The monarch of Ava, enraged at these defeats, sent large reinforcements to his dispirited and beaten army; and early in July a new attack was commenced on the British line, with no better success than before. On the 8th the British general directed an assault to be made on the enemy's entrenched positions, in which the armament on the river co-operated with the land force. The enemy were beaten as formerly at all points; and their strongest stoccaded works, battered to pieces by a powerful artillery, were in general abandoned by their defenders. Towards the end of August an attack was made on the British position by the prince of Sarawaddy, which was quickly repelled. But with this exception, the enemy having learned by fatal experience the necessity of caution, allowed the British to remain unmolested in their quarters during the months of July and August. This interval of leisure was employed by Sir A. Campbell in subduing the maritime provinces of the Burmese to the east, namely, Tavoy, Mergui, and the whole coast of Tennasserim, which quickly submitted to the British arms. This was an important conquest, as the country proved to be salubrious, and afforded convalescent stations to the sick, who were now so numerous in the British army, owing to severe duty, and to the incessant rains and privations of every kind to which they were exposed, that scarcely 3000 soldiers fit for duty could be mustered in the lines. The climate of Mergui proved to be so healthy that the sick who had been languishing for months at Rangoon rapidly recovered.¹ An expedition was about this time sent against the old Portuguese fort and factory of Syriam, at the mouth of the Pegu river, which was taken; and in October the province of Martaban was reduced under the authority of the British.

The rainy season terminated about the end of October, and the court of Ava, alarmed by the discomfiture of its numerous armies, resolved on recalling the veteran legions

¹ *Narrative of the Burmese War*, by Major Snodgrass.

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which were employed in Arracan, under their renowned leader Maha Bandoola, in vain attempts to penetrate the British frontier. Relinquishing his plans of offensive war, Bandoola, with his army, hastened by forced marches to the defence of his country, and, by the end of November, an army of 60,000 men had surrounded the British position at Rangoon and Kemmendine, for the defence of which Sir Archibald Campbell had only 5000 efficient troops. On the 1st December the enemy in great force made repeated attacks on the post of Kemmendine, noways daunted by the heavy broadsides which were poured from the shipping in the river. These attacks were invariably repulsed by the steadiness of the troops—the last, which was made after dusk, with great loss; and the fire rafts which had been set afloat for the destruction of the shipping, were towed ashore by the sailors, where they occasioned no injury. Several encounters took place with the enemy on the succeeding days; and on the 7th the army of Bandoola was completely routed in a general attack by Sir A. Campbell. The fugitives retired to a strong position on the river, which they again entrenched; and they were here attacked by the British on the 12th, who, surmounting every obstacle, carried the stoccaded ramparts at the point of the bayonet, and drove the enemy in complete confusion from the field. After this defeat the remnant of the Burmese army retreated to Donabew.

Sir Archibald Campbell, thus victorious in every encounter, now resolved to advance on Prome, about 100 miles higher up the Irrawaddy river. Having provided the means of transport, and having succeeded in acquiring the confidence of the inhabitants, many of whom had returned to their homes, and were found extremely useful to the army, he moved with his force in two divisions along different branches of the Irrawaddy. By the 22d he reached Sarrawah, about 50 miles from Rangoon. Here he expected intelligence of the reduction of Donabew by the force under General Cotton, which was left in the rear for that purpose. He had advanced 26 miles farther when he learned that General Cotton's attack on Donabew had failed. He instantly began a retrograde march; on the 27th he effected a junction with General Cotton's force, and on the 2d April carried the entrenchments at Donabew with little resistance, the enemy being panic-struck by the death of the general-in-chief, Maha Bandoola, who was killed by the explosion of a bomb. Sir A. Campbell, resuming his march to Prome, entered that place on the 25th, the Burmese flying at his approach, after setting fire to the town. Here he remained during the rainy season to refresh his troops, exhausted by privations and severe service. On the 17th September an armistice was concluded between the contending armies for one month. In the course of the summer General Morrison had conquered the province of Arracan; in the north the Burmese were expelled from Assam; and the British had made some progress in Cachar, though their advance was finally impeded by the thick forests and jungle with which the country was covered.

The armistice between the Burmese and Sir A. Campbell having expired on the 17th October, the army of Ava, amounting to 60,000 men, advanced in three divisions against the British position at Prome, which was defended by 3000 Europeans and 2000 native troops. But the science, courage, superior equipment, and high discipline of the British still triumphed over the undisciplined hordes of the Burmese army, who being hastily brought together, and inexperienced in war, were unable to withstand the close encounter of their veteran adversaries. After several actions, in which the Burmese were the assailants, and were partially successful, Sir A. Campbell, on the 1st December, attacked the different divisions of

their army, which were imprudently separated from each other, and which, notwithstanding the entrenchments by which they were protected, were, in the course of four days, successively driven from all their positions and dispersed in every direction. The Burmese retired on Meaday and afterwards on Mellone, along the course of the Irrawaddy, where they occupied with 10,000 or 12,000 men a series of strongly fortified heights and a formidable stoccade. On the 26th they sent a flag of truce to the British camp, and a negociation having commenced, peace was proposed to them on the following conditions: 1st, The cession of Arracan, together with the provinces of Mergui, Tavoy, and Yea; 2d, The kingdom of Assam and its contiguous petty states, and also Munnipore, were to be placed under princes and residents named by the British government; 3d, The company to be paid a crore of rupees as an indemnification for the expenses of the war; 4th, Residents from each court to be allowed, with an escort of fifty men. It was also stipulated that British ships should no longer be obliged to unship their rudders and land their guns as formerly in the Burmese ports. This treaty was agreed to and signed, but the ratification of the king was still wanting; and it was soon apparent that the Burmese had no intention to send it, but were preparing to renew the contest. On the 17th January, accordingly, Sir A. Campbell attacked the enemy's position at Mellone and carried it, the Burmese troops abandoning their defences in complete disorder. Another offer of peace was here made, which was found to be insincere, and the fugitive army resolved to make at Pagahm-Mew a final stand in defence of the capital. They were attacked and overthrown on the 9th February 1826; and the invading force being now within four days' march of Ava, Dr Prince, an American missionary, who, with other Europeans, had been thrown into prison when the war commenced, was sent to the British camp with the treaty ratified, the prisoners of war released, and the stipulated instalment of 25 lacs of rupees. The war was thus brought to a successful termination, and the British army immediately began its retreat. Mr Craufurd has since this period resided on the part of the British in the capital of the Burmese monarch, and from his work we derive much valuable information respecting the trade, resources, manners, and institutions of this people, who until the embassy of Colonel Symes in 1796 were almost entirely unknown to Europeans.

Ava, the capital of the Burman empire. It is situated on the Irrawaddy, which is here 3282 feet broad, and which, making a bend out of its ordinary course, flows past the city on the north. On the east it has the river Myit-nge, a rapid stream 450 feet broad, which flows into the Irrawaddy close under its walls. From this river a canal has been dug, through which its waters flow on the south-east angle of the city, and are again brought into the same river. On the south flows the deep and rapid torrent of the Myit-tha into the Irrawaddy, and thus forms the defences both of the south and west faces of the town. This place is divided into the upper and lower, or the lesser and the larger town, both of which are fortified. The brick wall that surrounds the city is 15½ feet in height and 10 feet in thickness, on the inside of which is thrown up a bank of earth, forming an angle of 45 degrees. There is a ditch round the outer wall, which is inconsiderable, and in the dry season fordable in every part. The wall round the upper or lesser town, which forms the north-east angle, is better constructed than that of the large town. The ditch over the south and west faces of it is also broader and deeper, and when full in the wet season is not to be forded. There are, however, three causeways across, which communicate with the surrounding country. The lesser town is mostly oc-

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cupied by the palace, the hall of justice, the council chamber, the arsenal, and the habitations of a few courtiers of distinction. A strong, well-built wall, about 20 feet high, surrounds the square in which these are situated; and on the outside of the wall is a teak-wood stockade of the same height. The circumference around the walls, and excluding the suburbs, is about $5\frac{1}{2}$ miles; but over this extensive area the houses are but thinly scattered, and some quarters are indeed wholly destitute of habitations, and have the appearance merely of neglected commons. In general the habitations of the inhabitants are of the most miserable sort, being mostly mere huts thatched with grass. Some of the dwellings of the chiefs are constructed of planks, and tiled; and there are not, according to Mr Craufurd, more than half a dozen houses built of brick and mortar. Ava, like all the other Burmese towns, is adorned with numerous temples, of which the gilded spires, rising aloft, present, on a distant view of the place, a splendid and imposing appearance, which is far from being realized on a nearer inspection. The largest of these temples contains two distinct edifices; one in the ancient, the other in the modern form; the former containing an image of Guatama, not of marble, as Symes supposes, but of sandstone. It is in a sitting posture, and is 24 feet in height. The head is eight feet in diameter. There is another very large temple, and a third called the "Beautiful." The one called Maong-Ratna is of great celebrity; it is the one in which the public officers of the government take, with the most solemn forms, the oath of allegiance. The temple called Maha-mrat-muni had an addition lately made to it, of which Mr Craufurd mentions that the numerous and richly-gilded pillars, and splendid ceiling, exceeded any thing that was to be seen without the palace. Ava contains eleven markets or bazaars, composed of thatched huts and sheds, which are well supplied with all that is necessary for the wants of the people. Besides native commodities, there is exposed in these markets the produce of China and Lao, with British cottons, woollens, glass

AVADOUTAS, a sect of Indian Brahmins, who in austerity surpass all the rest. The other sects retain earthen vessels for holding their provisions, and a stick to lean on; but none of these are used by the Avadoutas; they only cover their nakedness with a piece of cloth, and some of them even dispense with that, going quite naked, and besmearing their bodies with cow-dung. When hungry, some enter into houses, and, without speaking, hold out their hands; eating on the spot whatever is given them. Others retire to the sides of holy rivers, and there expect the peasants to bring them provisions, which they generally do very liberally.

AVAL. See BAHREIN.

AVALANCHES, a name given to prodigious masses of consolidated snow, which, disengaged from the summits or more elevated peaks, frequently roll down the sides of the Alps. See the article ALPS.

AVALLON, an arrondissement in the department of the Yonne, in France, extending over 456 square miles, or 291,840 acres, and comprehending five cantons, divided into seventy communes, with 43,295 inhabitants. The capital of the arrondissement is of the same name. It is situated on a bed of granite, at the foot of which the river Voisen flows. It has some manufactures of cloth, hats, hosiery, leather, and paper, and a considerable traffic in fire-wood, which, by the Voisen and the Eure, is conveyed into the Seine, and floated to Paris. It contains 1830 houses and 5483 inhabitants. Long. 3. 46. E. Lat. 47. 28. N.

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and earthen-ware. The Burman monasteries are mostly built of wood; and of these, consisting of more solid materials, a few ancient ones are all that are to be seen. The only exception is a monastery lately built by the queen, adjoining the palace, which is an unshapely fabric of immense size, and a very conspicuous object.

The capital of the Burman dominions, according to the political divisions of the empire, comprehends the town of Sagaing on the opposite shore of the Irrawaddy, and the town of Ummerapoor or Amarapura, four miles to the east, with large districts attached to each. The town of Sagaing extends along the Irrawaddy for more than a mile and a half, but is of inconsiderable breadth. It consists of mean houses, thinly scattered among gardens and orchards, the principal trees in the latter consisting of fine old tamarinds. Over the site of the town and its environs are scattered innumerable temples, some of them old and ruinous, others modern. On the river face it has a brick wall about ten feet in height, with parapet and embrasures like that of Ava, and extending for above half a mile along the river. Ummerapoor, to the east, is a large place, and was formerly the capital of Ava. But Ava, which was twice before the capital, was again made so in 1822, by his present majesty. To each of the towns of Ava, Sagaing, and Ummerapoor, are attached districts, which extend the two former twelve miles along the river, and are of equal breadth. The district of Ummerapoor is of equal size, so that Ava must be considered as not only the name of the capital, but of a large district around, which includes an area of 288 miles, containing, according to the most accurate estimate, 354,200 inhabitants. But the city of Ava is not supposed to contain more than 50,000 inhabitants; and, according to Mr Craufurd, half that number would be nearer the truth. Long. 96. E. Lat. 21. 50. N. (*Embassy to the Kingdom of Ava*, by Michael Symes; *Journal of a Residence in the Burman Empire*, by Captain Hiram Cox; *Narrative of the Burmese War*, by Major Snodgrass; *Journal of an Embassy to the Court of Ava in 1827*, by J. Craufurd.) (F.)

AVEIRO, a town of Portugal, in the province of Beira, containing a population of 7000 inhabitants. It has a thriving trade in oil, salt, and fish. Long. 8. 34. W. Lat. 40. 40. N.

AVEIRON or AVEYRON, a department so called from the river of the same name, which runs through it from east to west. It is bounded on the north by the department of Cantal, on the north-east by that of Lozère, on the east by that of the Gard, on the south-east by that of Hérault, on the south-west by that of the Tarn, and on the west by that of Lot. It extends over 3740 square miles, or 2,393,000 acres. The face of the country is mountainous and woody; and hence, though corn and wine are produced, and much cattle fed, the chief productions are fish, game, and wood. It contains mines of copper, iron, lead, alum, sulphur, and coal. The capital is Rodez. The population at the last census amounted to 327,424, and it sends to the legislative assembly three representatives.

AVELGHEM, a market-town on the left bank of the Scheld, in the circle of Courtray and province of West Flanders, in the Netherlands. It contains 3780 inhabitants.

AVELLA, a town of Naples, in the province of Terra di Lavoro, in a fine situation, and commanding most extensive prospects. It is distant about 15 miles from the city of Naples, and contains 5050 inhabitants.

AVELLINO, a large town of the Principato-Ultra, in

Ave-Maria the kingdom of Naples, about 25 miles to the eastward of the metropolis. It is the see of a bishop, and contains many churches, though with nothing peculiarly striking except some most grotesque ornaments. It is a manufacturing town of some consequence, and eminent for its blue cloth, the dyeing of which forms the patrimony of a princely family. The soil around is fertile, and provisions of all kinds are very abundant. The population amounts to 13,460 persons.

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Avenue.

AVE-MARIA, the angel Gabriel's salutation to the Virgin Mary, when he brought her the tidings of the incarnation. It is become a prayer or form of devotion in the Romish church. The chaplets and rosaries are divided into so many *ave-marias* and so many *pater-nosters*, to which the Papists ascribe a wonderful efficacy.

AVENCHES, a circle of the Canton Waadt or Vaud, in Switzerland, divided into two arrondissements, containing 3760 inhabitants. It is situated on the borders of the Murten Lake. The chief town is of the same name, and contains 1100 inhabitants, who cultivate fruits and tobacco.

AVENOR, an officer belonging to the king's stables, who provides oats for the horses. He acts by warrant from the master of the horse.

AVENTINE, JOHN, author of the *Annals of Bavaria*, was born in the year 1466, at Abensperg, in the country just named. He studied first at Ingoldstadt, and afterwards in the university of Paris. In 1503, he privately taught eloquence and poetry at Vienna, and, in 1507, he publicly taught Greek at Cracow in Poland. In 1509, he read lectures on some of Cicero's works at Ingoldstadt, and, in 1512, was appointed preceptor to Prince Louis and Prince Ernest, sons of Albert the Wise, duke of Bavaria, and travelled with the latter of these princes. After this he undertook to write the *Annals of Bavaria*, being encouraged by the dukes of that name, who settled a pension upon him, and gave him hopes that they would defray the charges of the book. This work, which gained its author great reputation, was first published in 1554, by Jerome Zieglerus, professor of poetry in the university of Ingoldstadt; and afterwards at Basil, in 1580, by Nicholas Cisner. He died in 1534, aged 68.

AVENTINUS MONS, one of the seven hills on which ancient Rome stood. The origin of the name *Aventinus* is uncertain; but this hill was also called *Murcius*, from Murcia, the goddess of sloth, who had a little chapel there; and *Collis Dianæ*, from the temple of Diana; likewise *Remonius*, from Remus, who wanted to build the city, and who was buried there. It was taken within the compass of the city by Ancus Martius. To the east it had the city walls, to the south the Campus Figulinus, to the west the Tiber, and to the north Mons Palatinus; in circuit two miles and a quarter.

AVENUE, in *Gardening*, a walk planted on each side with trees, and leading to a house, garden-gate, wood, &c. and generally terminated by some distant object. The trees most proper for avenues with us are the English elm, the lime, the horse-chestnut, the common chestnut, the beech, and the abele. The English elm will do in all grounds, except such as are very wet and shallow; and this is preferred to all other trees, because it will bear cutting, heading, or lopping in any manner, better than most others. The rough or smooth Dutch elm is approved by some, because of its quick growth. This is a tree which will bear removing very well; it is also green almost as soon as any plant whatever in spring, and con-

tinues so as long as any; it makes an incomparable hedge, and is preferable to all other trees for lofty espaliers. The lime is valued for its natural growth and fine shade. The horse-chestnut is proper for all places that are not too much exposed to rough winds. The common chestnut will do very well in a good soil, and rises to a considerable height when planted somewhat close, though when it stands single it is rather inclined to spread than to grow tall. The beech is a beautiful tree, and naturally grows well with us in its wild state; but it is less to be chosen for avenues than the before-mentioned, because it does not bear transplanting well, and is very subject to miscarry. Lastly, the abele is fit for any soil, and is the quickest grower of any forest tree. It seldom fails in transplanting, and succeeds very well in wet soils, in which the others are apt to fail. The oak is but little used for avenues, because of its slow growth.

AVENWEDDE, a town on the Dalke, with 2880 inhabitants, in the circle of Wiedenbruck and government of Menden, in the Prussian province of Westphalia.

AVENZOAR, ABU MERWAN ABDALMALEC EBN ZOHR, an eminent Arabian physician, who flourished about the end of the eleventh or the beginning of the twelfth century. He was of noble descent, and born at Seville, the capital of Andalusia, where he exercised his profession with great reputation. He was contemporary with Averroes, who, according to Leo Africanus, heard his lectures and learned physic of him. This seems the more probable, because Averroes more than once gives Avenzoar very high and deserved praise, calling him *admirable, glorious, the treasure of all knowledge, and the most supreme in physic from the time of Galen to his own*. Avenzoar, notwithstanding, is by the generality of writers reckoned an empiric; but Dr Freind observes that this character suits him less than any of the rest of the Arabians. He wrote a book entitled *The Method of Preparing Medicines and Diet*, which was translated into Hebrew in the year 1280, and thence into Latin by Paravicinus, whose version has passed through several editions.

AVERAGE,¹ a term used in commerce and navigation to signify a contribution made by the individuals to whom a ship, or the goods on board it, belong, or by whom it or they are insured, in order that no particular individual or individuals amongst them, who may have been forced to make a sacrifice, or submit to a loss for the preservation of the ship or cargo, or both, should lose more than others.

Average is either *general* or *particular*. General average is when a sacrifice is made for the common benefit of the ship and cargo, or a loss is incurred in providing for their mutual safety. "Thus," says Mr Sergeant Marshall, "when the goods of a particular merchant are thrown overboard in a storm, to save the ship from sinking; or when the masts, cables, anchors, or other furniture of the ship are cut away or destroyed for the preservation of the whole; or money or goods are given as a composition to pirates to save the rest, or an expense is incurred in reclaiming the ship, or defending a suit in a foreign court of admiralty, and obtaining her discharge from an unjust capture or detention; in these and the like cases, when any sacrifice is deliberately and voluntarily made, or any expense fairly and *bona fide* incurred to prevent a total loss, such sacrifice or expense is the proper subject of a general contribution, and ought to be mutually borne by the owners of the ship, freight, and cargo, so that the loss may fall equally on all, according to the equitable maxim

Aven-
wedde
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Average.

¹ Average is said by Cowell to be derived from the Latin word *averagium*, from the verb *averare*, to carry. He supposes it to have been introduced into commerce to show the proportion to be paid by every man according to his goods carried. Loccenius, on the other hand, derives it from the French *havre*, or the German *haben*, a port; it being a contribution paid for having goods brought safely to port. (*De Jure Maritimo*, lib. ii. cap. viii. sect. 1.)

Average. of the civil law, *nemo debet locupletari aliena jactura.*" (On Insurance, book i. chap. xii. sect. 7.)

Particular average is when a sacrifice is made for the sake of the ship only, or of the cargo only, or when a loss is incurred on account of one or other of them. General average affects all who have any interest in the ship or cargo, proportionally to that interest; particular average affects only the owners of the ship, or the owners of the cargo, or part of the cargo.

There are also some small charges, called *petty* or *accustomed* averages. They consist of disbursements on account of pilotage, light-houses, beaconage, quarantine, &c. When these charges are incurred in the ordinary course of the voyage, they are not considered as a general average, but are set down, one third to the ship, and two thirds to the cargo. If, however, they are incurred for any extraordinary purpose, or to relieve the ship and cargo from some impending danger, they are to be reputed general average.

The word *average* is also met with in bills of lading, when it is said that so much freight shall be paid for the goods "with *primage* and *average* accustomed." In this sense it merely signifies a small duty or premium, which those who send goods in ships belonging to others are in the habit of paying to the master, over and above the freight, for his care and attention to the goods intrusted to him.

The doctrine of average contributions seems to have grown out of the necessity which must have been early experienced, of occasionally throwing overboard part of a cargo, in order to provide for the safety of the remainder. The justice of making those whose property was saved contribute to place those who had been called upon to submit to such a sacrifice in the same situation as themselves, is so very obvious, that it could not long escape the notice of commercial legislators. The principle is clearly laid down in the Rhodian law, "Omnium contributione sarcitur (it is there said), quod pro omnibus datum est. *Æquissimum enim est, commune detrimentum fieri eorum qui, propter amissas res aliorum, consecuti sunt, ut merces suas salvas haberent.*" (*Dig. lib. xiv. tit. 2.*) This sound principle, with some of the cases illustrating its application, was early embodied in the Roman law; and having been applied and modified according to the greater experience afforded by the extraordinary extension of navigation, the subject of average forms a most important and interesting chapter in all modern systems of maritime jurisprudence.

No general average ever takes place unless it can be shown that the danger was imminent, and that the sacrifice made was *indispensable*, or *believed to be indispensable*, by the captain and officers, for the safety of the ship and cargo. It has been stated (*Lex Mercat.* 148), that in order to legalize the act of throwing goods overboard, three things must concur:

1st, That what is so condemned to destruction be in consequence of a deliberate and voluntary consultation held between the master and men;

2dly, That the ship be in distress, and that sacrificing a part be necessary, in order to preserve the rest;

3dly, That the saving of the ship and cargo be actually owing to the means used with that sole view.

But, however desirable, deliberate consultation is not to be expected when danger is imminent; and, in point of fact, the only thing necessary to legalize the *jettison*, as it is termed, is that it be deemed essential by the master and seamen for the common safety. Provided it be the effect of danger and the cause of security, all authorities agree that contribution ought to be made, though the forms may not have been complied with. "Previous deliberation, if there be time to deliberate, and a due choice

of the heaviest and most cumbersome articles, may be proofs of the necessity and propriety of the act; but they are not the *only* nor the *essential* proofs. Indeed, in this case, as in many others, too close a compliance with forms, at a period of supposed danger, has very justly excited a suspicion of fraud. In all cases, however, and in all countries, it is justly required of the master, that he draw up an account of the jettison, and verify the same by the oath of himself and some of his crew, as soon as possible after his arrival at any port, that there may be no opportunity to purloin goods from the ship, and then pretend they were cast over in the hour of danger." (Abbott, Lord Tenterden, *On the Law of Shipping*, part. iii. cap. 8.)

The third condition above stated as requisite to warrant a general contribution, viz. "that the saving of the ship and cargo be actually owing to the means used with that sole view," is not only incapable of proof, but is in itself unreasonable and absurd. There is, however, no contribution, unless the ship and the rest of the cargo be saved. Hence, if goods be thrown overboard in a storm, and the ship afterwards perish in the same storm, there is no contribution of the goods saved, if any, because the object for which the goods were thrown overboard was not attained. But if a ship, preserved by a jettison, and continuing her course, be afterwards lost, the goods saved from this last misfortune, if any, must contribute to the loss sustained by the jettison, because to it their preservation at a previous period was owing. (Marshall, b. i. c. xii. § 7.)

No general average takes place in consequence of a jettison that has been rendered necessary by the ship being overloaded, or by goods being placed in some improper place, as on the deck. The loss in such cases falls wholly on the owners and master; for it must have originated either in the negligence or misconduct of one or both of those parties. (Loccenius *De Jure Maritimo*, lib. ii. c. viii. § 14.)

Formerly it was a customary practice in this, as it still is in some foreign countries, to ransom ships when captured by an enemy, the ransom being made good by general average. But this practice having been deemed disadvantageous, was abolished by statute 22 Geo. III. c. 25, which declares, "That all contracts and agreements which shall be entered into, and all bills, notes, and other securities which shall be given, by any person or persons, for ransom of any ship or vessel, merchandise or goods, captured by the subjects of any state at war with his majesty, or by any person committing hostilities against his majesty's subjects, shall be absolutely void in law, and of no effect whatever." Any person entering into such a contract is subjected to a penalty of L.500.

The principles already laid down apply equally to all injuries done to the ship, or to extraordinary expenses incurred on her account, for the common safety. Thus, if damage be voluntarily done to a ship, by cutting her sides or deck to facilitate a necessary jettison, or by running her on shore to avoid an enemy or the danger of a storm; or if the captain, compelled by necessity, cut away and abandon his masts, or any other part of the rigging or furniture, to lighten the ship in the moment of distress; the loss and expenses occasioned by these sacrifices must be made good by a general average.

But injuries to the ship, not voluntarily incurred for her safety and that of the cargo, are not compensated by general average. Whatever happens in the ordinary course of wear and tear, or by a peril of the sea, as the loss of masts, sails, &c. in a storm, is *particular* average, and falls on the owners only. The ship, to borrow the admirable illustration given in the civil law, is like the tool or instru-

Average. ment of a workman in his trade. If in doing his work he break his hammer, his anvil, or any other instrument, he can claim no satisfaction for this from his employer. "Si conservatis mercibus deterior facta sit navis, aut si quid exarmaverit, nulla facienda est collatio: quia dissimilis earum rerum causa sit, quæ navis gratia parentur, et earum pro quibus mercedem aliquis acceperit. Nam etsi faber incudem aut malleum fregerit, non imputaretur ei qui locaverit opus: sed si voluntate vectorum vel propter aliquem metum id detrimentum factum sit, hoc ipsum sarciri oportet." (*Dig. lib. xiv. tit. 2.*)

Much doubt has been entertained whether the expenses incurred by a ship in an *intermediate* port, in which she has taken refuge, should be general average or fall only on the ship. But on principle, at least, it seems pretty obvious, that if the retreat of the ship to the intermediate port be made in order to obviate the danger of foundering, or some other great and imminent calamity, the expenses incurred in entering it, and during the time she is obliged by *stress of weather* or adverse winds to continue in it, should belong to general average. But if the retreat of the ship to port be made in order to repair any injury occasioned by the unskilfulness of the master, or in consequence of any defect in her outfit, such, for example, as deficiencies of water, provisions, sails, &c., with which she ought to have been sufficiently supplied before setting out, the expenses should fall wholly on the owners.

When a ship, supposed to be *sea-worthy*, is forced to take refuge in an intermediate port because of a loss occasioned by a peril of the sea, as the springing of a mast, &c., then, as the accident is not ascribable to any fault of the master or owners, and the retreat to port is indispensable for the safety of the ship and cargo, it would seem that *any extraordinary expense incurred in navigating the ship into port* ought to be made good by general average.

Supposing, however, that it could be shown that the ship was not at the outset *sea-worthy*, or in a condition to withstand the ordinary perils of the sea; that the mast, for example, which has sprung, had been previously damaged; or supposing that the mischief had been occasioned by the incapacity of the master; the whole blame would, in such a case, be ascribable to the owners, who, besides defraying every expense, should be made liable in damages to the freighters for the delay that would necessarily take place in completing the voyage, and for whatever injury might be done to the cargo.

These, however, are merely the conclusions to which, as it appears to us, those should come who look only to principle. The law with respect to most of the points now stated differs in different countries, and has differed in the same country at different periods. "A doubt," says Lord Tenterden, "was formerly entertained as to the expenses of a ship in a port in which she had taken refuge to repair the damage occasioned by a tempest; but this has been removed by late decisions,—and it has been held that the wages and provisions of the crew during such a period must fall upon the ship alone. But if a ship should necessarily go into an intermediate port for the purpose of repairing such a damage as is in itself a proper object of general contribution, possibly the wages, &c. during the period of such detention, may also be held to be general average, on the ground that the accessory should follow the nature of its principal." (*Law of Shipping*, part iii. chap. 8.)

Perhaps the reader who reflects on the vagueness of this passage will be disposed to concur with Lord Tenterden's remark in another part of the same chapter, "That the determinations of the English courts of justice furnish less of authority on this subject (average) than on any other branch of maritime law."

Average. Within these few years it was decided, in the case of a British ship that had been obliged to put into port in consequence of an injury resulting from her accidentally coming into collision with another ship, that so much of the repair she then underwent as was *absolutely necessary to enable her to perform her voyage*, should be general average. (*Plummer v. Wildman*, 3 M. and S. 482.) The judges, however, spoke rather doubtfully on the subject; and it is not very easy to discover any good grounds for the judgment. According to the usual terms of the charter-party, the owners bind themselves, "that the ship shall be tight, staunch, and strong, and furnished with all necessities for the intended voyage;" and also, "that *during the course of the voyage* the ship shall be kept tight and staunch, and furnished with sufficient men and other necessities, to the best of the owners' endeavours." And these conditions are no more than what the law requires of every owner who takes goods on board without a charter-party. Seeing, therefore, that the owners are bound to carry the cargo to its destination, they must consequently be bound, in the event of the ship sustaining any accidental or natural damage during the course of the voyage, either to repair that damage at their own expense, or to provide another ship to forward the goods. In point of fact, too, such subsidiary ships have frequently been provided; but we have yet to learn that it was ever pretended that their hire was to be defrayed by a general average, though, according to the principle of the decision in the case alluded to, this should be the case.

Practically, it is now the custom in this country, when a vessel puts into port on account of damage belonging to particular average, which requires to be repaired before she can safely proceed on her voyage, to allow as general average the expense of entering the port and unloading; to charge the owners of the goods or their underwriters with the warehouse rent and expenses attending the cargo; and to throw the expense of reloading and departure on the freight.

According to the law of England, when a ship is injured by coming into collision with or *running foul* of another, if the misfortune has been accidental, and no blame can be ascribed to either party, the owners of the damaged ship have to bear the loss; but when blame can be fairly imputed to one of the parties, it of course falls upon him to make good the loss done to the other. The regulations in the *Code de Commerce* (art. 407) harmonize in this respect with the law of England. According to the laws of Oleron and Wisby, however, and the famous French ordinance of 1681, the damage occasioned by an accidental collision is to be defrayed equally by both parties.

The laws of different states, and the opinions of the ablest jurists, vary as to whether the loss incurred in defending a ship against an enemy or pirate, and in the treatment of the wounded officers and men, should be made good by general average. The ordinance of the Hanse Towns (art. 35), the ordinance of 1681 (liv. iii. tit. 7, art. 6), and the *Code de Commerce* (art. 400, § 6), explicitly declare that the charges on account of medicine and attendance upon the officers and seamen wounded in defending the ship shall be general average. A regulation of this sort seems to be founded on reason. But other codes are silent on the subject; and though the contrary opinion had been advanced by Mr Serjeant Marshall, and by Mr Justice Park in the earlier editions of his work, the Court of Common Pleas has unanimously decided, that in England neither the expense of repairing a ship injured by successfully resisting and beating off an enemy, nor the cost of curing the wounds incurred by the sailors in the action, nor the ammunition expended

Average. in it, was the subject of general average. (Taylor v. Curtis, 2 Marsh. 309.)

Perhaps the most that can be said in favour of this decision is, that it is conformable to the opinion of Emerigon (*Traité des Assurances*, tome i. p. 627), who contends that an attack of pirates or enemies is to be considered in the same point of view as any ordinary *peril of the sea*. But though Emerigon supports his opinion with great learning, the principle on which it is founded appears to be altogether unsound. Losses voluntarily incurred, in cutting down masts, rigging, &c. in order to avert a peril of the sea, are, as every one allows, peculiarly proper subjects for general average; but an attack by an enemy or pirate is a danger that is, in most cases, of the most imminent kind, and cannot be resisted without voluntary sacrifices, involving the risk of death on the part of the crew; and if such sacrifices be made, and the danger be in consequence averted, it seems quite clear, even on Emerigon's own ground, that they cannot, either consistently or justly, be made particular average.

The ordinance of the Hanse Towns (art. 35) declares that such seamen as are maimed or disabled in defending a ship against an enemy or pirate, shall be maintained at the public expense during the remainder of their lives.

The ship, freight, and every thing remaining on board that can be deemed a part of the cargo, must contribute to general average. Money, plate, and jewels, though their *weight* could not have increased the danger of the ship, are not exempted; for the advantage derived from the sacrifice was not in proportion to the *weight*, but to the *value* of the things saved. But the persons on board, their wearing apparel, and the jewels or ornaments belonging to these persons, do not contribute. Neither are the seamen's wages subjected to this charge; if they were, they might sometimes, perhaps, be tempted to resist a sacrifice necessary for the general safety.

Different states have adopted different modes of valuing the articles which are to contribute to an average. In this respect the law of England has varied considerably at different periods. At present, however, the ship is valued at the price she was worth at the port of delivery; and most foreign states follow the same rule. The value of the freight is the clear sum which the ship has earned, after seamen's wages, pilotage, and all such small charges as come under the name of *petty averages*, are deducted. It was formerly the custom in England to value the goods lost or thrown overboard at *prime cost*, if the loss happened before half the voyage was performed; but if after, then at the price they would have borne at the port of delivery. But this distinction has been exploded, and it is now the settled practice with us to estimate the goods lost, as well as those saved, at the price they would have fetched at the port of delivery on the ship's arrival there, freight, duties, and other charges, being deducted. Each person's share of the loss bears, of course, the same proportion to the value of his property that the whole loss bears to the aggregate value of the ship, freight, and cargo. The necessity of taking the goods lost into this account is obvious, for otherwise their owners would be the only persons who would not be losers.

When the loss of masts, cables, and other furniture of the ship is the subject of general average, it is usual, as the new articles will in all ordinary cases be of greater value than those that have been lost, to deduct *one third* from the value of the former, leaving two thirds only to be contributed.

But the mode of adjusting an average loss will be better understood by the following example, extracted from Lord Tenterden's work *On the Law of Shipping*.

"The reader will suppose that it became necessary

in the Downs to cut the cable of a ship destined for Hull; that the ship afterwards struck upon the Goodwin, which compelled the master to cut away his mast, and cast overboard part of the cargo, in which operation another part was injured; and that the ship, having cleared from the sands, was forced to take refuge in Ramsgate harbour, to avoid the further effects of the storm.

"Amount of Losses.

"Goods of A cast overboard.....	L.500
"Damage of the goods of B by the jettison.....	200
"Freight of the goods cast overboard.....	100
"Price of a new cable, anchor, and mast.....	L.300
"Deduct one-third.....	100
	200
"Expense of bringing the ship off the sands.....	50
"Pilotage and port dues going into the harbour and out, and commission to the agent who made the disbursements.....	100
"Expenses there.....	25
"Adjusting this average.....	4
"Postage.....	1

"Total of losses.....L.1180

"Value of Articles to contribute.

"Goods of A cast overboard.....	L.500
"Sound value of the goods of B, deducting freight and charges.....	1000
"Goods of C.....	500
"Of D.....	2000
"Of E.....	5000
"Value of the ship.....	2000
"Clear freight, deducting wages, victuals, &c.....	800

"Total of contributory value.....L.11800

"Then L.11,800 : L.1180 :: L.100 : L.10.

"That is, each person will lose 10 per cent. upon the value of his interest in the cargo, ship, or freight.

Therefore A loses L.50

B 100

C 50

D 200

E 500

The owners 280

"Total.....L.1180, which is the exact amount of the losses.

"Upon this calculation the owners are to lose L.280; but they are to receive from the contribution L.380 to make good their disbursements, and L.100 more for the freight of the goods thrown overboard, or L.480 minus.....L.280

"They therefore are actually to receive.....200

"A is to contribute L.50, but has lost L.500; therefore A is to receive.....450

"B is to contribute L.100, but has lost L.200; therefore B is to receive.....100

"Total to be actually received.....L.750

"On the other hand C, D, and E have lost nothing; and are to pay as before, viz.....

C L.50

D 200

E 500

"Total to be actually paid.....L.750 which is exactly equal to the total to be actually received, and must be paid by and to each person in valuable proportion.

"In the above estimate of losses I have included the freight of the goods thrown overboard, which appears to be proper, as the freight of these goods is to be paid, and

Average their supposed value is taken, clear of freight as well as other charges." (*Law of Shipping*, part iii. chap. 8.)

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Avernus.

The subject of average does not necessarily make a part of the law of insurance; but as insurers, from the terms of most policies, are liable to indemnify the insured against those contributions which are denominated general average, its consideration very frequently occurs in questions as to partial losses. But in order to confine assurances to that which ought to be their only object, namely, an indemnity against real and important losses arising from the perils of the sea, as well as to obviate disputes respecting losses arising from the perishable quality of the goods insured, and all trivial subjects of difference and litigation, it seems to be the general law of all maritime states, and is expressly, indeed, provided by the famous ordinance of 1681 (see liv. iii. tit. 6, § 47, and the elaborate commentary of M. Valin), that the insurer shall not be liable to any claim on account of average unless it exceed *one* per cent. An article (No. 408) to the same effect is inserted in the *Code de Commerce*; and, by stipulation, this limitation is frequently extended in French policies to three or four per cent. A similar practice, and for a similar object, was adopted in this country in 1749. It is now constantly stipulated in all policies, that upon certain enumerated articles of a quality peculiarly perishable, the insurer shall not be liable for any partial loss whatever; that upon certain others, liable to partial injuries, but less difficult to be preserved at sea, he shall only be liable for partial losses above *five* per cent.; and that as to all other goods, and also the ship and freight, he shall only be liable for partial losses above *three* per cent. This stipulation is made by a memorandum inserted at the bottom of all policies done at Lloyd's, of the following tenor: "N.B. Corn, fish, salt, fruit, flour, and seeds, are warranted free from average, unless general, or the ship be stranded; sugar, tobacco, hemp, flax, hides, and skins, are warranted free from average under five pounds per cent.; and all other goods free from average under three pounds per cent., unless general, or the ship be stranded."

The form of this memorandum was universally used, as well by the Royal Exchange and London Assurance Companies as by private underwriters, till 1754, when it was decided that a ship having run aground was a stranded ship within the meaning of the memorandum, and that although she got off again the underwriters were liable to an average or partial loss upon damaged corn. This decision induced the two companies to strike the words, "*or the ship be stranded*," out of the memorandum, so that now they consider themselves liable to no losses which can happen to such commodities, except general averages and total losses. The old form is still retained by the private underwriters.

For further information with respect to this important subject the reader is referred to the famous work of M. Valin, *Commentaire sur l'Ordonnance de 1681*, tome ii. p. 147-198, ed. 1760; to Emerigon, *Traité des Assurances*, tome i. p. 598-674; Park on *Insurance*, chap. vii.; Marshall on *Insurance*, book i. chap. xii. sect. 7; Stevens's *Essay on Average*; Benecke *On the Principles of Indemnity in Marine Insurance*; Lord Tenterden's excellent work on the *Law of Shipping*, part iii. chap. viii. &c. (c. c.)

AVERDUPUIS. See AVOIRDUPUIS.

AVERNES, or AVENNES, a small but well-fortified town in Hainault, on the frontier of France towards the Netherlands. It is the head of an arrondissement in the department of the North, and contains a population of 2700. Long. 4. E. Lat. 50. 7. N.

AVERNUS, a lake of Campania in Italy, near Baia, famous among the ancients for its poisonous qualities. It is described by Strabo as situated within the Lucrine Bay,

deep and darksome, surrounded with steep overhanging banks, and only accessible by the narrow passage through which you sail in. Black aged groves stretched their boughs over the watery abyss, and with impenetrable foliage excluded almost every ray of wholesome light; and mephitic vapours ascending from the hot bowels of the earth, being denied free passage to the upper atmosphere, floated along the surface in poisonous mists. These circumstances produced horrors fit for such gloomy deities; while a colony of Cimmerians, as well suited to the rites as the place itself, cut dwellings in the bosom of the surrounding hills, and officiated as priests of Tartarus. Superstition, always delighting in dark ideas, early and eagerly seized upon this noxious spot, and hither she led her trembling votaries to celebrate her dismal orgies. Here she evoked the manes of departed heroes; here she offered sacrifices to the gods of the infernal regions, and attempted to dive into the secrets of futurity. Poets enlarged upon the popular theme, and painted its awful scenery with the strongest colours of their art. Homer brings Ulysses to Avernus, as to the mouth of the infernal abodes; and, in imitation of the Grecian bard, Virgil conducts his hero to the same gloomy regions. Whoever sailed thither, first did sacrifice, and endeavoured to propitiate the infernal powers, with the assistance of some priests, who attended upon the place and directed the mystic performance. Within, a fountain of pure water broke out just over the sea, which was fancied to be a vein of the river Styx. Near this fountain was the oracle; and the hot waters, frequent in those parts, were supposed to be branches of the burning Phlegethon. The poisonous effluvia from this lake were said to be so strong that they proved fatal to birds endeavouring to fly over it. Virgil ascribes the exhalation, not to the lake itself, but to the cavern near it, which was called *Avernus*, or *Cave of the Sybil*, and through which the poets feigned a descent to Orcus. Hence the proper name of the lake is *Lacus Avernus*, the lake near the cavern, as it is called by some ancient authors.

The sanctity of these shades remained unimpeached for many ages. Hannibal marched his army to offer incense at this altar; but it may be suspected he was led to such an act of devotion rather by the hopes of surprising the garrison of Puteoli, than by his piety. After a long reign of undisturbed gloom and celebrity, a sudden glare of light was let in upon Avernus; the horrors were dispelled, and with them vanished the sanctity of the lake. The axe of Agrippa levelled its forest with the ground, disturbed its sleepy waters with ships, and gave room for all its malignant effluvia to escape. The virulence of these exhalations, as described by ancient authors, has appeared so very extraordinary, that some modern writers, who know the place in a cleared state only, charge these accounts with exaggeration; but others think them entitled to more respect, since even now the air is feverish and dangerous, as the jaundiced faces of the vine-dressers, who have succeeded the Sybils and Cimmerians in the possession of the temple, most ruefully testify.

AVERROES, one of the most subtle philosophers that ever appeared among the Arabians, flourished at the end of the eleventh and beginning of the twelfth century. He was the son of the high-priest and chief judge of Cordoba in Spain; and, educated in the university of Morocco, he studied natural philosophy, medicine, mathematics, law, and divinity. He died at Morocco in the year 1206. He was excessively fat, though he ate but once a day. He spent all his nights in the study of philosophy, and when he felt fatigued, amused himself with reading poetry or history. He was extremely fond of Aristotle's works, and wrote commentaries on them; whence he was styled

Avernus
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Averroes.

Averroists *the commentator* by way of eminence. He likewise wrote a work on the whole art of physic, besides many amatory verses; but when he grew old, he very wisely threw these last into the fire.

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Avicenna.

AVERROISTS, a sect of Peripatetic philosophers, who appeared in Italy some time before the restoration of learning, and attacked the immortality of the soul. They took their denomination from Averroes, from whom they borrowed their distinguishing doctrine. The Averroists held that the soul was mortal, according to reason or philosophy, yet pretended to submit to the Christian theology, which declares it immortal. But the distinction was accounted suspicious; and this divorce of faith from reason was rejected by the doctors of that time, and condemned by the last council of the Lateran under pope Leo X.

AVERRUNCI (DEI), certain gods, whose business it was, according to the Pagan theology, to avert misfortunes. Apollo and Hercules were of the number of these gods among the Greeks, and Castor and Pollux among the Romans.

AVERSA, a town of Italy, in the kingdom of Naples, and a bishop's see. It is situated in a very fine plain, in long. 14. 20. E. lat. 41. 0. N.

AVES, one of the Carribbee Islands, 451 miles south of Porto Rico, with a good harbour for the careening of ships. It is so called from the great number of birds that frequent it. There is another of the same name lying to the northward of this, in lat. 15. 0. N.; and a third near the eastern coast of Newfoundland, in lat. 50. 5. N.

AVESBURY, ROBERT, an English historian, of whom little more is known than that he was keeper of the registry of the court of Canterbury in the reign of Edward III. and consequently that he lived in the fourteenth century. He wrote *Memorabilia gesta magnifici regis Angliæ domini Edwardi Tertii post Conquestum, procerumque; tactis primitus quibusdam gestis de tempore patris sui domini Edwardi Secundi, quæ in regnis Angliæ, Scotiæ, et Franciæ, ac in Aquitania et Britannia, non humana sed Dei potentia, contigerunt*. This history ends with the battle of Poitiers, about the year 1356. It continued in manuscript till the year 1720, when it was printed by Hearne at Oxford, from a manuscript belonging to Sir Thomas Seabright.

AVEZZANO, a town of Naples, in Abruzzo Ulteriore, containing about 2700 inhabitants. Long. 13. 32. E. Lat. 41. 58. N.

AVIARY, a place set apart for feeding and propagating birds. It should be so large as to give the birds some freedom of flight; and turfed, to avoid the appearance of foulness on the floor.

AVICENNA, or AVICENES, the prince of Arabian philosophers and physicians, was born at Assena, a village in the neighbourhood of Buckharia. His father was from Balkh in Persia, and had married at Buckharia. The first years of Avicenna were devoted to the study of the koran and the belles lettres. He soon showed what he was likely to become afterwards; and the progress he made was so rapid, that when he was but ten years old he was perfectly intelligent in the most hidden senses of the koran. Abu-Abdallah, a native of Naplous, in Syria, at that time professed philosophy at Buckharia with the greatest reputation. Avicenna studied under him the principles of logic; but being soon disgusted with the slow manner of the schools, he set about studying alone, and read all the authors who had written on philosophy, without any other help than that of their commentators. Possessed with an extreme desire to become acquainted with all sorts of sciences, he likewise devoted himself to the study of medicine; and, persuaded that the medical art consists as much

in practice as in theory, he sought every opportunity of visiting the sick, and afterwards confessed that he had learned more from experience than from all the books he had read. He was now in his sixteenth year, and was already celebrated as being the light of his age. At this period he resolved to resume his studies of philosophy, which medicine had caused him to neglect; and he spent a year and a half in this painful labour, without ever sleeping all the time a whole night together. If he felt himself oppressed by sleep or exhausted by study, a glass of wine refreshed his wasted spirits, and gave him new vigour for study; if, in spite of him, his eyes for a few minutes shut out the light, he then endeavoured to recollect and meditate upon all the things which had occupied his thoughts before sleep. At the age of twenty-one he conceived the bold design of incorporating, in one work, all the objects of human knowledge; and carried it into execution in a kind of Encyclopædia, to which he gave the title of the *Utility of Utilities*. He died at Hamadan, aged 58 years, in the 428th year of the Hegira, and of Christ 1036.

The knowledge he had of physic did not secure him from the ailments that afflict human nature. He was attacked by several maladies in the course of his life, and in particular was very subject to the colic. His excesses in pleasures, and his infirmities, made a poet who wrote his epitaph say, that the profound study of philosophy had not taught him good morals, nor that of medicine the art of preserving his own health.

Avicenna, after his death, enjoyed so great a reputation, that till the twelfth century he was preferred for the study of philosophy and medicine to all his predecessors. His works were the only writings in vogue in schools, even in Europe. The following are their titles:—1. Of the Utility and Advantage of Science, twenty books. 2. Of Innocence and Criminality, two books. 3. Of Health and Remedies, eighteen books. 4. Canons of Physic, fourteen books. 5. On Astronomical Observations, one book. 6. On Mathematical Sciences. 7. Of Theorems, or Mathematical and Theological Demonstrations, one book. 8. On the Arabic Language and its Properties, ten books. 9. On the Last Judgment. 10. On the Origin of the Soul, and the Resurrection of Bodies. 11. Of the End we should propose to ourselves in Harangues and Philosophical Argumentations. 12. Demonstration of the Collateral Lines in the Sphere. 13. Abridgement of Euclid. 14. On Finiteness and Infinity. 15. On Physics and Metaphysics. 16. On Animals and Vegetables, &c. 17. The Encyclopædia mentioned above.

AVIGLIANO, a small town of Piedmont in Italy. Long. 7. 5. E. Lat. 44. 40. N.

AVIGNON, an arrondissement in the department of Vaucluse, in France, the extent of which is 174 square miles, or 117,360 acres. It comprehends five cantons, divided into 21 communes, containing 52,504 inhabitants. The capital of the arrondissement is of the same name, and situated in a beautiful valley on the left bank of the Rhone. The city is surrounded by walls planted with trees, which form an agreeable promenade. The houses are old but large, the streets narrow and crooked, but some of the public edifices are magnificent. The dwellings at the last census were 2800, and the inhabitants 23,789. The chief object of industry is the preparation of silk and the manufacture of goods dependent on that substance. There are, besides, manufactures of paper, leather, hats, jewellery, and some other articles. Up to the French revolution the city belonged to the papal see, and was the residence of the several popes from 1303 to 1376. By an act of atrocious injustice it was seized by the republicans, and after some barbarous proceedings was at length united to France. Long. 4. 52. 20. E. Lat. 43. 56. 58. N.

Avigliano
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Avignon.

Avila
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Avlona.

AVILA, one of the four provinces into which Old Castile in Spain is divided. It is the least of the four, and most thinly peopled. The extent is 215 square leagues, and the population 118,061 souls. The high ridge of the mountains of Guadarrama separates it from the province of Madrid. The principal river which waters it is the Adaja, on which the capital Avila, a small and insignificant city, though the see of a bishop, is built. This province, once flourishing, has gradually declined in wealth and population during the last two centuries, and the exertions of industry have not been directed of late to improvement. The principal production is the wool of the Merino sheep, a great number of which are shorn in this province; and the fleeces, after being washed and sorted, are sent to the northern ports to be shipped to the different countries where they are consumed. It contains one city, 82 towns, 202 villages, 299 parishes, 28 monasteries, and 19 nunneries. The inhabitants obtain of wine 150,000, of brandy 2000, and of oil 3000 arobas, and of silk 300 cwt. It is situated between long. 4. 14. and 5. 55. W. and lat. 30. 48. and 41. 18. N.

AVILA, a town of Spain, in the province of Old Castile. It is situated on the banks of the river Adaja, which running towards the north and joining the Arevalillo, empties itself into the Duero. The town is situated on a plain, and the fields around it are highly productive in fruits and grain. It is the seat of a bishop, and has one cathedral, eight parish churches, sixteen monasteries, five hospitals, 1000 houses, and 4200 inhabitants. Long. 4. 59. W. Lat. 40. 43. N.

AVIO, a market-town with 2045 inhabitants, employed chiefly in the silk manufactory. It is situated on the river Etsch, in the Italian confines of Roveredo, in the Austrian principality of Tyrol.

AVIS, a walled town of Portugal, situated on the river of the same name in Alentejo, and containing about 1500 inhabitants. It is nine miles north-west of Estremoz.

AVISON, CHARLES, organist of Newcastle, and a disciple of Geminiani, was the author of an essay on musical expression, published in the year 1752, in which are some judicious reflections on music in general. Throughout his book he celebrates Marcello and Geminiani; the latter frequently to the prejudice of Mr. Handel. In the year 1753 came out *Remarks on Mr. Avison's Essay on Musical Expression*, the author whereof first points out sundry errors against the rules of composition in the works of Avison. In the same year Avison republished his essay, with a reply to the author of the remarks; and a letter, containing a number of loose particulars relating to music, collected in a course of various reading, unquestionably written by Dr. Jortin. Avison promoted and assisted in the publication of Marcello's music to the Psalms, adapted to English words. Of his own composition there are extant five collections of concertos for violins, forty-four in number, and two sets of sonatas for the harpsichord and two violins, a species of composition little known in England till his time. The music of Avison is light and elegant, but it wants originality; a necessary consequence of his too close attachment to the style of Geminiani, which in a few particulars only he was able to imitate.

AVLONA, a Turkish European paschalic, comprehending a part of the ancient Albania, and a province on the sea-coast. It is bounded on the north and north-east by the paschalic of Ilbessan, on the south-east by Yanina, on the south by Delonia, and on the west by the Adriatic Sea. The climate and soil resemble that of the south of France, and the productions are similar. The woods abound with game, and the rivers and coasts with fish. The chief trade is the export of corn, salt, and pitch, with some live cattle. The inhabitants amount to about 250,000,

of whom two thirds are Arnauts and Greeks of the Greek church, and one third Arnauts and Turks of the Mahomedan faith. The Kimariots are few in number, but lead a wild life among the mountains, in a kind of savage republican state of equality. Most of them are of the Greek faith, but some are Mahomedans. It extends from long. 19. 38. to 20. 25. E. and from lat. 39. 50. to 40. 51. N.

AVLONA, or VALONA, a city, the chief place of the province of the same name, deriving its name from the bay on which it is situated. The harbour is sheltered from all winds, and the anchorage is good, with never less than fifteen nor more than twenty-three fathoms in depth. It has about 5000 inhabitants, many of whom are employed in making arms of different kinds to supply the Arnauts. It is the seat of a Greek bishop.

AVOIRDUPOIS. This was formerly the weight used for the larger and coarser commodities, such as groceries, cheese, wool, lead, &c. The proportion of a pound avoirdupois to a pound troy is as 17 to 14.

AVOLA, a city of Sicily, in the intendency of Saragosa, on the sea-coast, with 6780 inhabitants. There are some sugar plantations near it, but from their unprofitableness they are nearly abandoned.

AVOSET. See ORNITHOLOGY.

AVRANCHES, an arrondissement in the department of Calvados, in France, the extent of which is 475 square miles, or 304,000 acres. It is divided into nine cantons, and these into 127 communes, containing 106,144 inhabitants. The capital of the arrondissement is of the same name. It stands on a hill, at the foot of which the river Seez flows, which at high tide is navigable from the sea, about three miles distant. It has some trade in corn, cider, and salt. The number of inhabitants is 6144. Long. 1. 25. E. Lat. 48. 41. N.

AVSTA, a mining village in the barony of Rasgard and province of Storakopparber (formerly Dalarleia), in Sweden. It suffered by fire in 1803, but has since been rebuilt and increased. It contains 115 houses and 600 inhabitants, all employed in the various mineral products of the vicinity. There is a mint for coining copper money.

AWA, in Japan, the capital of a province on the south coast of the island of Nippon, 85 miles south of Jeddo. Long. 140. 4. E. Lat. 34. 24. N.

AWARD, in Law, the judgment of an arbitrator, or of one who is not appointed by the law a judge, but chosen by the parties themselves for terminating their difference.

AWASI, or AWADSI, an island of Japan, about 60 miles in circumference. It is situated near the south coast of Nippon. Long. 133. 44. E. Lat. 34. 30. N.

AWL, among shoemakers, an instrument wherewith holes are bored through the leather to facilitate the stitching or sewing of the same. The blade of the awl is usually a little flat and bended, and the point ground to an acute angle.

AWME, or AUME, a Dutch liquid measure, containing eight steckens or twenty verges or verteels, equal to the tierce in England, or to one sixth of a ton in France.

AX, a carpenter's instrument for hewing wood. It is furnished with a long handle or helve, for the purpose of being used with both hands.

AXAMENTA, in Antiquity, a denomination given to the verses or songs of the *Salii*, which they sung in honour of all men. The word is formed, according to some, from *axare*, q. d. *nominare*. Others will have the *Carmina Salaria* to have been denominated *axamenta*, on account of their having been written in *axibus*, or on wooden tables. The *axamenta* were not composed, as some have asserted, but only sung by the *Salii*. The author of them was Numa Pompilius; and as the style might not be altered, they grew in time so obscure that the *Salii* them-

Avlona
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Axamenta.

Axamenta selves did not understand them. Varro says they were 700 years old. Quint. *Inst. Or.* lib. i. c. 11.

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Axino-
mancy.

AXAMENTA, or *Assamenta*, in ancient music, hymns or songs performed wholly with human voices.

AXBRIDGE, a market-town, formerly a borough, of the hundred of Winterstoke, in the county of Somerset. It stands on the river Ax, just below the range of the Mendip hills, near the great chasm through them known by the name of Chedder Clift. The corporation is of great antiquity, as is the large Gothic parish church. It is 130 miles from London. The market is held on Thursday. The population in 1801 amounted to 819, in 1811 to 853, and in 1821 to 988.

AXEL, a small fortified town in Dutch Flanders. Long. 40. 0. E. Lat. 51. 17. N.

AXHOLM, an island in the north-west part of Lincolnshire, in England, formed by the rivers Trent, Idle, and Dan. It is about twenty miles in circuit, and contains three villages, Crowle, Epworth, and Hyrst.

AXILLA, in *Anatomy*, the arm-pit, or the cavity under the upper part of the arm.

AXILLARY, something belonging to or lying near the axilla. Thus, *axillary artery* is that part of the subclavian branches of the ascending trunk of the aorta which passes under the arm-pits; *axillary glands* are situated under the arm-pits, enveloped in fat, and lie close by the axillary vessels; and *axillary vein* is one of the subclavians, which passes under the arm-pit, dividing itself into several branches, which are spread over the arm. See **ANATOMY**.

AXIM, a small territory on the Gold Coast of Africa, due east of Apollonia. The climate in this part is so excessively moist that it is proverbially said to rain eleven months and twenty-nine days of the year. This excessive moisture renders it very unhealthy, but it produces great quantities of rice, water melons, lemons, oranges, &c. Here are also produced vast numbers of black cattle, goats, sheep, tame pigeons, &c. The whole country is filled with beautiful and populous villages, and the intermediate lands are well cultivated; besides which the natives are very wealthy, from the constant traffic carried on with them by Europeans for their gold. The capital, which is also called *Axim*, by some *Achambone*, stands under the cannon of the Dutch fort St Antonio. This fort is commodious, in an agreeable and commanding position, and vessels may land with perfect safety. Behind, it is secured by a thick wood that covers the whole declivity of a neighbouring hill. Between the town and the sea runs an even and spacious shore of beautiful white sand. All the houses are separated by groves of cocoa and other fruit trees, planted in parallel lines, each of an equal width, and forming an elegant vista. The little river Axim crosses the town, and the coast is defended by a number of small pointed rocks which project from the shore, and render all access to it dangerous. The capital is situated in long. 24. 0. W. lat. 5. 0. N. This canton is a kind of republic, the government being divided between the Caboceroes or chief men, and Manaceroes or young men. It must be observed, however, that in their courts there is not even a pretence of justice; whoever makes the most valuable presents to the judges is sure to gain the cause, the judges themselves alleging the gratitude due for the bribes received as a reason; and if both parties happen to make presents of nearly equal value, they absolutely refuse to give the cause a hearing.

AXINOMANCY, **AXINOMANTIA**, from *ἀξιν*, *securis*, and *μαντεια*, *divinatio*; an ancient species of divination, or a method of foretelling future events by means of an ax or hatchet. This art was in considerable repute amongst the ancients, and was performed, according to some, by laying an agate stone on a red-hot hatchet, and also by fix-

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ing a hatchet on a round stake so as to be exactly poised; then the names of those suspected were repeated, and he at whose name the hatchet moved was pronounced guilty.

AXIOM, **AXIOMA** (from *ἀξιωμα*, *dignum censeo*, *I account worthy*), a self-evident truth, or a proposition the truth of which every person perceives at first sight. Thus, the whole is greater than a part; a thing cannot be and not be at the same time; and from nothing, nothing can arise; are propositions or truths of this description.

AXIOM is also an established or elementary principle in science. Thus, it is an axiom in physics, that nature does nothing in vain; that effects are proportional to their causes, &c. It is an axiom in geometry, that things equal to the same thing are also equal to one another; that if to equal things you add equals, the sums will be equal, &c. And it is an axiom in optics, that the angle of incidence is equal to the angle of reflection, &c.

AXIS, in *Geometry*, the straight line in a plain figure, about which it revolves, to produce or generate a solid. Thus, if a semicircle be moved round its diameter at rest, it will generate a sphere, the axis of which is that diameter.

AXIS, in *Astronomy*, is an imaginary right line supposed to pass through the centre of the earth, or through that of a heavenly body, about which it performs its diurnal revolutions.

AXIS, in *Conic Sections*, a right line dividing the section into two equal parts, and cutting all its ordinates at right angles.

AXIS, in *Mechanics*. The axis of a balance is that line about which it moves, or rather turns about. *Axis of oscillation* is a right line parallel to the horizon, passing through the centre, about which a pendulum vibrates.

AXIS in *Peritrochio*, one of the six mechanical powers, consisting of a peritrochium or wheel concentric with the base of a cylinder, and movable together with it about its axis.

AXIS, in *Optics*, is that particular ray of light, coming from any object, which falls perpendicularly on the eye.

Axis of a Vessel, is an imaginary right line passing through the middle of it, perpendicularly to its base, and equally distant from its sides.

AXMINSTER, a market-town in the hundred of the same name, in the county of Devon. It takes its name from the river Axe, on which it stands, and the ancient abbey church or minster which ornaments the centre of the town, and which was built by King Athelstane to commemorate a victory over the Danes. It is 147 miles from London, on the great road to Exeter, from which it is twenty-six miles distant. It is distinguished for its manufactory of the best and most costly description of carpets; and besides that, there is some trade in making gloves, tapes, and druggets. The market is held on Saturday. The population in 1801 amounted to 2154, in 1811 to 2387, and in 1821 to 2742.

AXUNGIA, in a general sense, denotes old lard, or the driest and hardest of any fat in the bodies of animals; but more properly it signifies only hog's lard.

AY, or **AI**, a town of France, in the department of Marne, containing 2500 inhabitants. It is celebrated for its wines, which are esteemed superior to any in Champagne. Five leagues south of Rheims.

AYAMONTE, a town of Spain, in the province of Seville. It is a sea-port in the centre of the gulf of Huelva. The Guadiana, increased by the stream of the Chauza, passes the town, and empties itself into the ocean at this spot. Ayamonte is well fortified, and the harbour is good, but, on account of a bar at its mouth, it is of difficult entrance. Considerable employment is furnished to the sailors of

Axiom
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Ayamonte.

Aylesbury
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Ayr.

this place by the fisheries, especially for sardinias and for the tunny, both of which are highly prized. It contains 5500 inhabitants. Silk spinning is carried on here. Lat. 37. 9. N. This also is the name of a town in Portugal, in the province of Alentejo, three miles north-west of Minfort.

AYLESBURY, a market and borough town of the hundred of the same name, in the county of Buckingham, and thirty-nine miles from London. It stands on a gentle hill in the centre of a fertile vale, through which one of those small streams runs, the waters of which contribute to form the Thames. It is favoured by the extension to it of the Grand Junction Canal, which affords water-carriage for coals and other heavy substances from Staffordshire, and brings it into connection with the metropolis. There is but little employment in manufactures, which are almost wholly confined to bone lace. The county jail is here, and the elections for the county are also held at Aylesbury, as well as the sessions, and in alternate times the assizes. The market is held on Saturday. The population in 1801 amounted to 3186, in 1811 to 3447, and in 1821 to 4404.

AYLMER, JOHN, bishop of London in the reign of Queen Elizabeth, was born in the year 1521, at Aylmerhall, in the parish of Tilney, in the county of Norfolk. Whilst a boy, he was distinguished for his quick parts by the marquis of Dorset, afterwards duke of Suffolk, who sent him to Cambridge, and made him his chaplain, and tutor to his children. One of these children was the unfortunate Lady Jane Grey, who soon became perfectly acquainted with the Latin and Greek languages. His first preferment was to the archdeaconry of Stow, in the diocese of Lincoln; which gave him a seat in the convocation held in the first year of Queen Mary, where he resolutely opposed the return to popery, to which the generality of the clergy were inclined. He was soon after obliged to flee his country and take shelter among the Protestants in Switzerland. On the accession of Queen Elizabeth he returned to England. In 1562, he obtained the archdeaconry of Lincoln, and was a member of the famous synod of that year, which reformed and settled the doctrine and discipline of the church of England. In the year 1576, he was consecrated bishop of London. He died in the year 1594, aged 73, and was buried in St Paul's. He was a learned man, a zealous father of the church, and a bitter enemy to the Puritans. He published a piece entitled *An Harborowe for Faithfull and Trewe Subjects against the late blowne Blaste concerning the Government of Women*, &c. This was written whilst he was abroad, in answer to Knox, who published a book in Geneva under this title, *The First Blast of the Trumpet against the Monstrous Regiment and Empire of Women*. He is supposed by Strype to have published Lady Jane Grey's letter to Harding. He also assisted Fox in translating his *History of Martyrs* into Latin.

AYLSHAM, a market-town of the hundred of South Erpingham, in the county of Norfolk, 112 miles from London. It has a good market-place, is a cheerful looking town, and is connected with the sea by a navigable canal. There was formerly some trade in knitting stockings, which has much declined of late years. The market is held on Saturday. The population in 1801 amounted to 1667, in 1811 to 1760, and in 1821 to 1853.

AYMARGUES, a city in the arrondissement of Nismes and department of the Gard, in France. It is situated on the bank of the Rosny, and has 1800 inhabitants, with brandy distilleries.

AYORA, a well-built town, pleasantly situated, in the government of Cofrentes and province of Valencia, in Spain, containing 5850 inhabitants.

AYR, a royal burgh, the capital of Ayrshire, is situated

at the influx of the river Ayr into the Irish Sea. The spot has been inhabited from a remote antiquity. It was the site of a Roman station; and it has been ascertained that a hamlet remained here until the year 1197, when William the Lion engrafted a new town upon it, which about the year 1202 he constituted a royal burgh. In ancient times Ayr was distinguished both for its trade and military strength; and being an important point of concentration on the west, it was the scene of frequent conflict, and repeatedly changed hands during the wars of Scottish independence in the times of the Edwards and the Bruces. Here Edward I. fixed a powerful garrison, and here the patriotic exploits of Sir William Wallace commenced. When Scotland was overrun by Oliver Cromwell, he fixed upon it as the site of one of the four forts which he built to command the country. This fortification, termed the citadel, inclosed an area of about ten or twelve acres, including the old church where the Scottish parliament met and confirmed the title of Robert Bruce to the throne: but the church was converted into a storehouse; the Protector partly indemnifying the inhabitants for this seizure by liberally contributing towards the erection of a new place of worship, which was made large enough to accommodate 2000 individuals. The town of Ayr forms a tolerably regular parallelogram, extending up the south side of the river Ayr, which is crossed by two bridges; and it possesses several good streets and a number of elegant public and other buildings. The Ayr academy is a handsome edifice; and the town-house, recently erected, is considered the finest structure of the kind in the west of Scotland. There are also the county buildings, which afford extensive accommodation for the circuit and provincial courts and the various local authorities. Contiguous to these stands the jail, a well-regulated establishment. In addition to the church already mentioned, there is a modern erection, besides several dissenting places of worship and a Roman Catholic chapel. Ayr possesses numerous charitable establishments, a dispensary, a flourishing mechanics' institution, an extensive subscription library; and it also supports a weekly newspaper. There are two weekly markets and four yearly fairs. The principal manufactures of Ayr are tanning, boot and shoe making, soap-boiling, and ship-building to a small extent. The trade of the port is carried on in small vessels only, the water never rising above twelve feet. The exportations, however, are extensive for the size of the town; consisting of coal, iron, brown paint, coal-tar, casks, lamp-black, soapers' salts, and Water-of-Ayr stones. The imports are also considerable from South America, the colonies, and Ireland; consisting of hides, tallow, beef, butter, barley, yarn, linen, spars, deals, hemp, &c. Two reflecting light-houses are erected to guide vessels to the entrance of the harbour. There is a steam-boat conveyance to and from Glasgow during the summer months, and there are regular traders to several of the principal English and Scottish ports. It is 75 miles S. W. of Edinburgh. Long. 4. 37. W. Lat. 55. 27. N. The population of the burgh and parish in 1831 was 7606.

AYR, NEWTON UPON. While the burgh of Ayr extends along the south side of the river Ayr, this small parish is situated on the north side of the same river. It is a burgh of considerable consequence, having a baronial jurisdiction, and governed by a magistracy elected by freemen, but without parliamentary representation. It is of very ancient erection, owing its privileges to Robert Bruce; who, upon being attacked by leprosy, came to reside in this place, and was induced to establish a lazaret, and to confer considerable favours on the town, and on the small village of Priestwick, about two or three miles distant. In Newton-upon-Ayr are a number of very good houses.

Ayr.

Ayr It has a tolerably good harbour, chiefly occupied with the coal trade. From its situation on the banks of the Ayr and the sea-coast, the soil is mostly flat and sandy. Its extent is about three miles in length and one and a half in breadth. In 1811 the population was 2809.

Ayr, a river in Ayrshire, which takes its rise in the high grounds dividing the shire on the east from Lanarkshire, and, pursuing a westerly course for 18 miles, falls into the sea at the town to which it gives name. The volume of its waters is not large, but it sometimes shifts its bed, and does considerable damage. It contains those whetstones called Water-of-Ayr stones, which are exported in considerable quantities.

AYRSHIRE, a county in the west of Scotland, considerable for its population and industry, is bounded by Wigtonshire and the stewartry of Kirkcudbright on the south, by the counties of Dumfries and Lanark on the north-east and east, by Renfrewshire on the north, and by the Irish Sea and the Frith of Clyde for about 70 miles on the west. It contains about 1060 square miles, or 665,600 statute acres, consisting of the following descriptions of soil, viz. clay soil 261,960 acres, sand or light soil 120,110 acres, and of moss and moorlands 283,530 acres. About one half of the whole is now under cultivation. The middle part of the county is broadest, and extends to about 25 miles across, both ends diminishing to a few miles in breadth. The high ridgy land which stretches along its eastern boundary shuts it out, in a general sense, from the adjacent counties, and the surface inclines either to the sea or to the rivers which flow towards it. Ayrshire possesses only six rivers of note, Ayr, Stinchar, Girvan, Doon, Irvine, and Garnock; but the streams are very numerous, and fresh-water lakes abound, of which Doon is the most extensive, and the parent of the river bearing that name. None of the mountains are deserving of particular notice. In former times the shire was divided into three districts; Carrick, lying on the southern side of the Doon; Kyle, lying between the rivers Doon and Irvine; and Cunningham, comprehending the whole of the county north of the river Irvine. These divisions, although abolished by the statute, still continue to be recognised in statistical descriptions of the county. Carrick is a hilly, wild region, and only of value in its northern quarter. It contains nine parishes, and comprises 393 square miles. Kyle possesses much valuable land towards the coast, but the interior is rough and mountainous; it contains twenty-one parishes, with a superficies of 403 square miles. But the most fertile part of the county is Cunningham, which is comparatively level, comprising 244 square miles, and sixteen parishes. The valued rent is L.191,605 0s. 7d. Scots, and in 1811 the real rent of the lands was L.336,471 10s., and that of the houses L.22,823 sterling. The division of property is considered as not unfavourable to the prosperity of the different classes of the population, though it appears that more than a third part of the whole county is held under settlements of entail. The advantages possessed by Ayrshire, besides its sea-coast and several excellent harbours, may be traced to the coal and limestone found in great abundance in almost every part of it,—the one so necessary to its manufactures, and the other to its agriculture; and the chief natural disadvantage under which it labours is the humidity of its climate, aggravated by the quality of a considerable part of the soil, which is a tenacious clay.

Agriculture.

Agriculture, according to the more approved courses of management, has nevertheless made considerable progress of late in this county. The old rotation of three consecutive crops of corn, followed by six years hay and pasture, has been very generally abandoned in the new leases; and, on the better soils, an alternation of white

and green crops, and an interchange of tillage and pasturage, as in the eastern counties of Scotland, begin to prevail. The dairy is, however, the chief object of attention to the Ayrshire husbandmen, and their valuable breed of cows, and rich yet mild cheese known by the name of Dunlop cheese, are in great repute in most parts of Britain. Their horses, under the general name of Clydesdale or Lanarkshire horses, are equal, if not superior, to those of any other race in the island; almost every small farmer (and the farms are generally too small) either rearing one or more himself, or purchasing them when young, and reselling them to the eastern counties after a year or two of very moderate labour. Nevertheless, it must be admitted that the agriculture of Ayrshire is much inferior to that of the counties on the east coast. No regular system of cleansing and manuring the soil, nor of fallowing and draining the wet lands, is to be seen throughout the greater part of the district. The size of the farms is commonly from 50 to 150 acres, affording little scope for the employment of capital or the division of labour; and yet the rents are surprisingly high, some favoured spots bringing not less than eight pounds or guineas an acre.

Ayrshire, as a manufacturing district, seems to stand next in importance among the Scottish counties to the contiguous shires of Lanark and Renfrew. Various branches of the woollen manufacture are carried on to a considerable extent in different parts of it. In Kilmarnock, harness and printed worsted shawls are manufactured to the yearly amount of L.200,000, carpets to L.100,000, boots and shoes to L.32,000, and bonnets to L.12,000; and besides the public establishments there, and in other parts of the county, many private families in almost every parish take a share in the manufacture of blankets and coarse cloths; a part of which, after supplying their own wants, is carried to the fairs and markets of the county. Beith has long been noted for its thread manufacture. But the cotton works at Catrine are by far the most extensive of all its manufactories, employing about 1800 hands, who are said to make 35,000 yards of cloth per week. At Muirkirk and Glenbuck, pig and bar iron are wrought to a great extent, and founderies have been erected there and in other places. Leather, saddlery, earthenware, kelp, and salt, are the only other kinds of manufacture worthy of notice in this county.

Ayr, Irvine, and Saltcoats, were, till very lately, the only harbours much frequented; and at these places there has long been a little trade with Ireland, America, and the Baltic, and a considerable trade coastwise. The port of Ayr has 60 small vessels of about 6000 tons burden; and Irvine, Saltcoats, Troon, Ardrossan, Largs, and Arran, 100 vessels of about 10,000 tons burden. Coal is the staple article of export, and corn the most considerable of its imports; the ports on the Clyde having hitherto been the grand emporium of the west of Scotland.

This county exhibits examples of public spirit in its great landed proprietors beyond any other in Scotland, or probably in the British empire. The harbour and other works at Ardrossan, begun under the auspices of the late Earl of Eglintoun, the harbour of Troon, and the railway from thence to Kilmarnock, formed almost entirely at the expense of the Duke of Portland, are worthy monuments, no less of the enlightened judgment and energy, than of the wealth, of these two patriotic noblemen; and the distant prospect of remuneration, which it is much to be wished could be amply realized, can detract in no respect from the merit of such grand and princely undertakings.

The harbour of Ardrossan has been for many years in a state to receive shipping, and is considered as one of the safest, most capacious, and most accessible on the west coast of Scotland; possessing many advantages over the

Ayrshire.

Ayrshire
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Ayscue.
Ardrossan
harbour.

harbours in the Frith of Clyde, situate in a narrow channel, which can be navigated only when the wind blows from particular points, and which, for upwards of twenty miles below Glasgow, is both shallow and dangerous. A circular pier of 900 yards was finished in 1811; and the wet dock and other appendages, which, according to Mr Telford's plan, were to contain from 70 to 100 vessels, in water sixteen feet deep, were begun and nearly completed, when the death of the Earl of Eglinton in 1820 brought them to a stand. They were merely suspended, however, and will be resumed when the present earl attains majority, which will happen in a year or two. It was part of the plan to raise a neat, regular-built town at Ardrossan, in which some progress has been made; and excellent baths have been constructed, which draw to it a number of visitors during the summer season.

Canal.

The harbour of Ardrossan was only part of the general plan, and that from which, viewed by itself, the smallest advantages perhaps were to be expected. The leading idea was to open up a direct communication between Glasgow, Paisley, and other large towns in the vicinity, and the west coast, instead of the present circuitous passage by the Frith of Clyde. A canal was therefore to be cut from Glasgow to Ardrossan, about thirty-one and a half miles, at the estimated expense of L.125,000. Of this only a third has been executed, that is, from Glasgow

to Johnstone, which cost about L.90,000. The rest of the track will be completed by a railway, of which some miles have been already laid from Ardrossan eastwards.

The harbour at Troon, connected as it now is with Kilmarnock, by means of a railway, seems to possess all the advantages of that of Ardrossan. The wet and dry docks are also excellent, and very well employed. There are also extensive warehouses, and a yard for building vessels. The railway from Troon to Kilmarnock, a distance of ten miles, has been in full operation for fifteen years, and answers all the purposes for which it was originally intended. There are upwards of 3000 acres of coal fields in its course, which must in time indemnify the duke of Portland for his outlay both on this and the harbour. Coals have been hitherto the principal article of conveyance towards the Troon, at the rate of 100 tons daily; and from thence timber, iron, grain, &c. are transported to Kilmarnock and the country adjacent. Locomotive engines were attempted upon it about 15 years ago, but the experiment did not succeed. However, from the improvements recently made upon these machines, it is probable that they may soon be resumed. This railway has cost the duke upwards of L.50,000, and the harbour is estimated at about the same sum.

The following abstract will exhibit a comparative view of the population of Ayrshire in 1811, 1821, and 1831:—

1811.

DISTRICTS.	HOUSES.			OCCUPATIONS.			PERSONS.		
	Inhabited.	By how many Families occupied.	Uninhabited.	Families chiefly employed in Agriculture.	Families chiefly employed in Trade, Manufactures, or Handicraft.	All other Families not comprised in the two preceding classes.	Males.	Females.	Total of Persons.
Carrick	2,997	3,450	132	1,474	1,335	641	7,665	8,557	16,222
Cunningham	6,206	10,167	138	1,725	6,133	2,390	21,390	24,737	46,127
Kyle	6,204	7,877	192	2,186	3,886	1,805	19,451	22,154	41,605
	15,407	21,494	462	5,385	11,354	4,755	48,506	55,448	103,954

1821.

DISTRICTS.	HOUSES.			OCCUPATIONS.			PERSONS.		
	Inhabited.	By how many Families occupied.	Uninhabited.	Families chiefly employed in Agriculture.	Families chiefly employed in Trade, Manufactures, or Handicraft.	All other Families not comprised in the two preceding classes.	Males.	Females.	Total of Persons.
Carrick	3,608	4,888	110	1,690	2,586	612	10,523	10,803	21,326
Cunningham	7,419	11,775	143	2,375	7,505	1,895	26,426	29,404	55,830
Kyle	6,815	9,982	153	2,142	4,917	2,923	24,128	26,015	50,143
	17,842	26,645	406	6,207	15,008	5,430	61,077	66,222	127,299

In 1831 the population of Carrick amounted to 25,536; of Cunningham to 63,506; and of Kyle to 56,066; total 145,108.

AYRAINES, a town in the department of the Somme and the arrondissement of Amurs, in France, with a population of 1560 inhabitants.

AYRY, or AERY, of hawks, a nest or company of hawks, so called from the old French word *aire*, which signifies the same thing.

AYSCUE, SIR GEORGE, a gallant English admiral, descended from a good family in Lincolnshire. He ob-

tained the honour of knighthood from King Charles I., which, however, did not withhold him from adhering to the parliament in the civil war. He was by them constituted admiral of the Irish seas, where he is said to have done great service to the Protestant interest, and to have contributed much to the reduction of the whole island. In 1651 he reduced Barbadoes and Virginia, then held for the king, to the obedience of the parliament; and soon

Ayrshire
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Ayscue.
Troon har-
bour.

Railway.

Ayton after the Restoration behaved with much gallantry in the war with the Dutch. In the famous engagement in the beginning of June 1666, when Sir George was admiral of the white squadron, his ship, the Royal Prince, ran upon the Gallop-sand, where, being surrounded with enemies, his men obliged him to strike. He went no more to sea after this, but spent the rest of his days in retirement.

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Azerbaijan.

AYTON, a village and parish of Scotland, in the county of Berwick, on the river Eye. The population is 1379. It is $7\frac{1}{2}$ miles west of Berwick.

AZAMOR, a small sea-port of the kingdom of Morocco, in Africa. It is situated on the river Morbeya, in the province of Duguella, at a considerable distance from its mouth. This town, though formerly very considerable, is ill fitted for maritime commerce, the entrance of the river being very dangerous. It was unsuccessfully besieged by the Portuguese in 1508; it was taken, however, in 1513, by the duke of Braganza, but abandoned about the end of the sixteenth century. According to Mr Jackson, the present population does not exceed 1000. Long. 8. 15. W. Lat. 33. 20. N.

AZARIAH, or **UZZIAH**, a king of Judah, succeeded his father Amaziah, 810 years before Christ. He assembled an army of above 300,000 men, with which he conquered the Philistines, demolishing the walls of Gath, Jabniel, and Ashdod, and built up the walls of Jerusalem, furnished the city with conduits, and planted gardens and vineyards; but at last, being elated with his prosperity, and resolving to usurp the office of high-priest, he was struck with leprosy, which obliged him to remain shut up in his palace for the rest of his days. He died about 759 years before the Christian era, and was succeeded by Jotham his son. There are several other persons of this name mentioned in the sacred Scriptures.

AZAZEL. This word relates to the history of the scape-goat, under the Jewish religion. Some call the goat itself by this name, as St Jerome and Theodoret. Dr Spenser says, the scape-goat was to be sent to Azazel, by which is meant the devil. M. Le Clerc translates it *præcipitium*, making it that steep and inaccessible place to which the goat was sent, and where it was supposed to perish.

AZEITAO, a town of Portugal, in the bailiwick of St Ubes and province of Estremadura. It is situated on a small river that runs into the Tagus, and contains 552 houses, with 2342 inhabitants. There is here a calico printing manufactory, as well as several tanneries.

AZERBIJAN, a province of Persia, part of the ancient Media. It is separated from Armenia on the north by the river Araxes, and from Irak on the south by the Kizilozein or Golden stream. It has the Caspian Sea and Ghilan on the east, and Armenia and Kurdistan on the west. The country is superior to the southern provinces of Persia, being richly diversified with wood and water. It differs entirely from the provinces of Fars and Irak, as it consists of a regular succession of undulating eminences, partially cultivated, and opening into plains, such as Anjan, Tabreez, and Urumea or Ooroomea or Van. To the south the mountains of Sahund rise in an accumulated mass to the clouds; and on the north the black rocks of the district of Karabang disappear in the luxuriant vegetation of the plain of Mogam, which is 225 miles in length by seventy-five in breadth, and famed for its luxuriant pastures. Azerbaijan is a fertile country, and of a most pleasing aspect. It is reckoned one of the most productive provinces of Persia, and the villages have a more pleasing appearance than those of Irak. The orchards and gardens, in which they are for the most part embosomed, yield delicious fruits of almost every description. Provisions are cheap and abundant, and wine is made in considerable

quantities. This province is watered by several considerable rivers, namely, the Araxes, the Kizilozein, and the Jugatty, which issues from the mountains of Ardelan, and is perhaps larger than either. The other rivers are the Yezdican, which has its source sixty miles east of Lake Urumea, and joins the Araxes; the Agi, whose waters are drained away in irrigation; and the Shar, which falls into the lake of Urumea. This is a great lake, about 300 miles in circumference. Its waters are more intensely salt than the sea. It is surrounded by some of the most fertile districts in Persia. The country to the north and west, namely, the districts of Ooroomea and Selmart, contains, the first 400 villages, and the second between 300 and 400 villages, flourishing and populous. This is the most picturesque and the most prosperous part of Azerbaijan; yet even here the traveller from the more civilized regions of Europe laments at every step the sloth and want of enterprise among the inhabitants, who entirely neglect the natural advantages of their country. There are many rivers which fall into the lake, by which the produce of the rich and well-cultivated valleys through which they run might be transported across its waters, and dispersed among the different towns in the province. But there is not a single boat on this extensive expanse of water. The truth is, that individual exertion is damped by the tyranny of the government; the inhabitants fearing, that if boats were constructed for the navigation of the lake, they would be subjected to heavy duties, or arbitrarily impressed into the service of government. The bulk of the people are so held down by their rulers, that, in the hope of bettering their condition, they would hail with pleasure the approach of a Russian army. Lead, copper, saltpetre, and sulphur, are found within the confines of Azerbaijan; also a kind of beautiful transparent marble or jasper, which takes the highest polish, and is used in the buildings of Tabreez, Schiraz, and Ispahan, under the name of Tabreez marble. The province is divided into twelve districts. The chief towns are Tabriz or Tabreez, containing 30,000 inhabitants; Meanna, Ardebil, Shebustar; Tasouj, in ruins; Selmart, with 2000 inhabitants; Khoe, with 25,000; Ooroomea, with 12,000; and Maraga, with 15,000. The climate is healthful, in summer and autumn hot, but cold in winter, which is severely felt by the lower orders, owing to the want of fuel, for which there is no substitute except dried cow-dung mixed with straw. The spring is temperate and delightful in the plains, but on the mountains snow lies for eight months in the year; and hail storms are so violent as frequently to destroy cattle in the fields. The best soils yield from fifty to sixty fold when abundantly irrigated; and supplies of water for this purpose are drawn from the many small rivers by which the province is intersected. Oxen are generally used to draw the plough. (Kinneir's *Geographical Memoir of the Persian Empire*; Fraser's *Travels and Adventures in the Persian Provinces on the Caspian Sea*.)

AZIMUTH, in *Astronomy*, an arch of the horizon, intercepted between the meridian of the place and the vertical circle passing through the centre of the object.

Magnetical AZIMUTH, an arch of the horizon, intercepted between the vertical circle passing through the centre of any heavenly body and the magnetical meridian.

AZIMUTH Compass, an instrument for finding either the magnetical azimuth or amplitude of a heavenly object.

AZIMUTH Circles, called also *azimuths* or *vertical circles*, are great circles of the sphere intersecting each other in the zenith and nadir, and cutting the horizon at right angles. On these are reckoned the height of the stars and that of the sun when not in the meridian.

AZOGA SHIPS were those Spanish ships commonly called the *quicksilver ships*, from their carrying quicksilver

Azimuth
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Azoga
Ships.

Azoni
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Azores.

to the Spanish West Indies, in order to extract the silver from the ore obtained in the mines of Mexico and Peru. These ships were not permitted to carry goods unless for the king of Spain's account.

AZONI, in *Ancient Mythology*, a name applied by the Greeks to such of the gods as were deities at large, not appropriated to the worship of any particular town or country, but acknowledged in general by all countries, and worshipped by every nation. These the Latins called *dii communes*. Of this sort were the Sun, Mars, Luna, &c.

AZOPH or Asow, a city on the sea of that name, situated at the embouchure of the river Don. It was formerly a place of great importance, but has declined since 1774, when it became a fixed part of the Russian empire. The harbour is nearly choked up, and the fortifications are neglected. It now contains about 3000 inhabitants, chiefly occupied in fishery. The country around, although unhealthy, is fruitful in vines. It is in long. 39. 8. E. and lat. 47. 6. N.

AZORES, or WESTERN ISLANDS. These form a range situate in the Atlantic Ocean, extending in an oblique line from north-west to south-east, between the 37th and 40th degrees of north latitude, and the 25th and 32d degrees of west longitude. It has been a subject of some controversy among geographers, to what quarter of the world they ought to be referred. Originally attached to Africa, they were afterwards, with evident impropriety, transferred to America, and are now more generally viewed as part of Europe, although their connection with and general resemblance to the other African groups rather incline us to adhere to the first arrangement.

It does not appear that the ancients had any knowledge of the Azores, or of any group in this sea, except the Canaries, to which they finally applied the celebrated appellation of the Fortunate Islands. But the Arabian geographers, Edrisi and Ibn al Vardi, describe, after the Canaries, nine other islands, situate in the Western Ocean. That these were the Azores is rendered highly probable, by considering that their number is exactly nine, and that mention is made by these writers of the abundance of a species of eagle or hawk; a circumstance which afterwards appeared to the Portuguese so remarkable, that they derived the name of the islands from it. The climate in which they are placed also makes them north of the Canaries. Some other coincidences might be pointed out did our limits permit; and, upon the whole, we see no reason to doubt that the Azores are really the nine islands enumerated by the Arabians, although two of the number might probably be Madeira and Porto Santo, whilst the small islands of Corvo and Flores might remain unnoticed. The Arabian writers represent them as having been populous, and as having contained cities of some magnitude; but they state that the inhabitants had been greatly reduced by intestine warfare.

The first European discovery of this group is claimed by the Flemings. The Portuguese, eagerly bent upon pursuing their career of navigation along the coast of Africa, did not readily turn into any other direction. A Flemish merchant, called Van der Berg, is reported, in sailing from Lisbon, to have been driven upon these shores. The intelligence soon reached the court of Lisbon, where it excited considerable interest. It is even said that Prince Henry went in person to examine the value of this new discovery. In 1459 the islands began to be planted and colonized, and in so fertile a soil the inhabitants rapidly multiplied. In 1466 Alphonzo V. is said to have granted them to his sister the Duchess of Burgundy, though in that case they must have soon reverted to the Portuguese crown. In 1580 they fell, with the other Portuguese territories, under the dominion of Spain.

The Azores were at this time the grand rendezvous in the voyage homewards of the fleets, which came laden with the wealth of both the Indies. Hence they became a theatre of that maritime warfare which was carried on with such spirit by the English under Queen Elizabeth against the peninsular powers. In 1586 Sir Walter Raleigh equipped two pinnaces of 35 and 40 tons, the command of which he gave to Captain Whiddon. Having taken two or three prizes, they fell in, off St Michael, with the great fleet of Spanish galleons, consisting of 24 sail, two of them caracks of 1000 or 1200 tons. They attacked them, however, without hesitation, hoping to cut off some straggling member of this great body. It will not surprise our readers that they were unable to make any impression upon it; but they retired without loss. In 1587 Sir Francis Drake, after having swept the harbour of Cadiz, sailed for the Azores, where he took an East India carack, richly laden, and the first that had ever fallen into the hands of the English. In 1589 the Earl of Cumberland fitted out a squadron, sailed for the Azores, and made numerous prizes.

Under the active administration of Pombal, considerable exertions were made for the improvement of the Azores; but the stupid and bigoted government which followed rather tended to destroy these benefits, and to make the islands take a retrograde course.

The Azores have of late attracted some attention as the theatre of contest between the parties contending for the crown of Portugal. The adherents of the constitution, who support against Miguel the rights of Maria da Gloria, obtained possession of Terceira, where they have succeeded in maintaining themselves. They have even by the latest accounts been able to occupy Fayal; but St Michael is still held by their adversaries.

In giving a description of these islands, we shall begin with St Michael, the largest and most populous, and the one in which the peculiar physical structure of the Azores is exhibited on the greatest scale. It consists generally of a fertile plain, but diversified by an infinite variety of hills and mountains, all bearing evident marks of volcanic action. The centre of the island contains chiefly small conical hills; but the eastern and western quarters rise into lofty mountains, with deep valleys and lakes intervening. The face of the country is almost everywhere smiling; the plains are covered with luxuriant crops; vines and oranges grow on the hills; and even the mountains are adorned with myrtles, laurels, and other evergreen shrubs. All appears a paradise; nor could the observer at first suspect that this was a spot chosen, as it were, by nature for the display of all her most terrible phenomena. The form of the mountains, however, soon indicates their history. There are few which, after being moulded by the volcano, have not been rent by the earthquake. In some cases the chasm is so complete, that a level path has been formed between the severed members. One of the most remarkable appearances of this kind occurs in the Porto de Ilheo, a small island about a quarter of a mile from the harbour of Villa Franca. Here a volcanic rock, 2000 feet high, has been completely split, exhibiting a chasm 39 feet wide from the top, to seven feet below the surface of the water. It thus forms, for a few small vessels, a harbour perfectly safe from every vicissitude of the weather.

In the year 1591 a most tremendous earthquake appears to have been felt all over the Azores, and to have shaken St Michael for twelve days without intermission. Since that period there is no record of any such great convulsion, except one in 1757, of which we have no particulars, and it was probably much less formidable; nor are any of its volcanoes at present in a state

Azores.

Azores. of action. Hot springs abound in every part of the island, and from almost every crevice vapour is seen issuing. But the most remarkable phenomena are the Caldeiras or boiling fountains, which rise chiefly from a valley called the Furnas, near the western extremity of the island. The water ascends in columns to the height of about twelve feet, after which it dissolves in vapour, forming clouds of various shapes and colours. The heat is such as to boil an egg in two minutes, though the sulphureous impregnation unfits it for being employed in culinary purposes. The ground in the immediate vicinity is entirely covered with native sulphur, like hoar frost. At a small distance is a remarkable phenomenon called the Muddy Crater, the vertex of which, forty-five feet in diameter, is on a level with the plain. Its contents are in a state of violent and continual ebullition, accompanied with a sound resembling the waves of a tempestuous ocean. Yet they never rise above its level, unless occasionally to throw to a small distance a spray of the consistence of melted lead. The Furnas abound also in hot springs, some of which it is impossible to touch without being scalded. There is almost always, however, a cold spring near to the hot one, so that the water can be brought to any temperature that may be desired. These springs, after being long neglected, have, within the last half century, been greatly resorted to, and the cures performed in cases of palsy, rheumatism, and similar maladies, are said to have been very wonderful.

St Michael is about 50 miles in length, and varies in breadth from about 5 to 12 miles. The plains are fertile in wheat, barley, and Indian corn; whilst vines and oranges grow luxuriantly on the sides of the mountains. They are made to spring even from the interstices of the volcanic rocks, which are sometimes blasted in order that they may receive the plants. Raised in this manner, these fruits are said to be of superior quality; but the great expense originally required in such a mode of cultivation confines it to persons of some capital. The western part of the island yields hemp, which might be raised to a considerable extent. There is also a mountain called *Pico de Fer*, which appears to be rich in iron, though no means are at present employed for extracting the ore. The exports consist of wine, fruit, and provisions. Foreign intercourse used to be confined rigorously to Lisbon; but since the emigration of the court, the inhabitants have assumed the privilege of trafficking directly with England, America, and other countries. After defraying the expense of its local government, it yields L.28,000 of revenue to the mother country.

The principal town in the island is Ponta del Gada, which contains about 12,000 inhabitants. It is built with tolerable regularity, the streets being straight and broad. The religious edifices are numerous and elegant. They consist of two large convents of the orders of St Francis and St Augustin, four for professed nuns, and three recolhimentos for such as are not professed. The harbour receives only small vessels: those of any magnitude must anchor in an open road, which, though not dangerous, cannot be occupied during the prevalence of southerly gales. It is, however, the best roadstead in the island. Ribeira Grande is also a large town on the south coast, containing nearly as many inhabitants as Ponta del Gada. It has two large convents, and there are several warm springs situate in its neighbourhood. Villa Franca, also, though nearly destroyed by the earthquake of 1591, is now a considerable city. Alagoa, Agoa de Pao, Porto Fermoza, and a few others, are also of some magnitude. The whole number of inhabitants in the island is estimated at 80,000 or 90,000. The people appear to be hospitable, but indolent and luxurious, and entirely under the dominion of the priesthood.

St Mary is a small island immediately adjacent to St Michael, through the medium of which its trade is conducted, as it has no good harbours of its own. It produces wheat in abundance, and exports a considerable quantity. The soil is composed of clay, which is partly manufactured into pottery.

Terceira, though smaller than St Michael, yet being placed in a more central position with respect to the other islands, has been chosen as the seat of government. The port of Angra is also superior to any of those in St Michael. This island does not exhibit nearly the same extensive traces of volcanic action; and the summits of its mountains are generally level. It is represented by Adanson, however, as entirely composed of volcanic products. The lava, he says, is of a thicker grain than that of Teneriffe. It abounds in grain and cattle; but the wines are inferior, and the fruits are raised merely for internal consumption. The residence of the government renders the society somewhat superior to that which is found in the other islands. The number of inhabitants is estimated at 50,000.

Fayal is the most frequented of all the islands, as it has the best harbour in the Azores, and lies directly in the track of vessels that are crossing the Atlantic in any direction. The principal town is called Villa de Horta. Captain Cook observes that all sorts of fresh provisions may be got there; the bullocks and hogs are good, but the sheep small and wretchedly poor. The town is defended by two castles and a wall, both in decay, and serving rather for show than strength. The city contains two convents for monks and three for nuns, with eight churches. These are the only good buildings in it, no other having glass windows. The bay is two miles in length and three quarters of a mile in breadth, and the depth of water from six to twenty fathoms. Though a good road, it is not altogether free from danger in south-south-west and south-east winds.

A considerable quantity of wine is exported from this place under the appellation of Fayal wine, but really the produce of Pico, one of the most remarkable of the Azores. This island is composed of an immense conical mountain, rising to the height of 7000 feet, and bearing every trace of volcanic formation. The soil consists entirely of pulverized lava, and the ground has even been said to sound hollow when struck. All the lower parts of the mountain are in the highest state of cultivation, and covered with vine and orange plantations. The wine annually exported to the amount of about 5000 pipes forms a sort of inferior Madeira, which, selling fifty per cent. lower, is in considerable demand. Pico produces also a valuable species of wood, resembling and equal in quality to mahogany.

Graciosa and St George are two small islands, situated between Fayal and Terceira. Graciosa is chiefly noted for the extreme beauty of its aspect and scenery. St George has recently been exposed to one of those awful visitations to which the Azores are subject. In 1808 a caldeira, situate in the centre of the island, was observed to be in a state of violent fermentation. It continued during several days to emit subterraneous noises, and to cause violent convulsions throughout every part of the island. At length the great crisis came; vast streams of fire issued forth in every direction, with clouds of smoke, which, but for the volcanic light, would have involved every thing in midnight darkness. The principal stream took its direction towards the beautiful town of Ursula, which it seemed on the point of swallowing up; but suddenly changing its direction, it rushed into the sea by a different channel; a happy event, which superstition ascribed to the prayers of the Ursuline nuns. Many hundred acres of fertile land, however, were covered with scorice and ashes; some lives were lost, and

Azores
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B.

Corvo and
Flores.

general gloom and consternation diffused throughout the island. The inhabitants, however, showed no disposition to emigrate, and soon applied themselves to repair the damages which their island had sustained.

The two small and most westerly islands of Corvo and Flores seem but imperfectly to belong to the group. They lie also out of the usual track of navigators; but to those who, missing their course, are led thither, Flores affords good shelter in its numerous bays. Its poultry is said to be the finest in the world; and the cattle are numerous, but small. The surplus produce of these islands is not of much importance.

It would be improper to close this notice without mentioning one of the most striking occurrences in nature, sometimes exhibited in this quarter—the sudden emersion of new islands from the bosom of the ocean. The first relation of such an event is given by Kircher in his *Mundus Subterraneus*. He describes it as announced by violent earthquakes, which lasted for eight days; then a fire broke from the surface of the sea, and rose to the clouds, whilst vast quantities of stones, earth, sand, and minerals, were at the same time vomited out. At length a group of rocks burst forth, which gradually increased till they covered several miles in circumference, and, after being shattered by a new earthquake, settled into a solid consistence.

A narrative of a similar phenomenon is given in the 32d volume of the *Philosophical Transactions*. John Robison, master of a small vessel, is stated to have arrived on the 10th December 1720 at Terceira, “near which island he saw a fire break out of the sea.” On his arrival at Angra, the governor hired his vessel for the purpose of going to view it. “On the 19th,” says he, “at two afternoon, we made an island all fire and smoke. The ashes fell on our deck like hail and snow. The fire and smoke roared like thunder or great guns.” He adds, that quantities of pumice stone, probably common lava, and of half-broiled fish, were found floating on the sea in its vicinity.

A similar phenomenon took place in February 1811, about half a league from the western extremity of the island of St Michael. It seems to have been attended with nearly the usual symptoms; fire bursting from the sea, and ascending into the air like a host of sky-rockets, accompanied with vast volumes of smoke and showers of scorix and lava. The rocks, however, did not rise above

the surface of the water, but appeared immediately under it, with the waves dashing furiously round them. The previous soundings are said to have been eighty fathoms.

On taking a general view of these phenomena, and of the other peculiarities of the Azores, it is impossible not to lament that they should not yet have been surveyed by any scientific observer; and we would fain entertain the hope that some traveller, properly qualified, may at length be induced to turn his attention to a group of islands which, more than any other, seems to offer a rich field of observation and discovery to geologists and naturalists in general.

See Hartmann's *Edrisi*; *Voyages des Hollandois*, tome i.; Astley's *Collection*, vol. i.; Masson's Account of St Miguel, in *Phil. Trans.* 1778; Cook's *Second Voyage*; Adanson's *Voyage to Senegal*; *History of the Azores*, London, 1813. (E.)

AZZARA, JOSEPH FELIX NICHOLAS DE, a celebrated Spanish naturalist. He was born in 1731, at Barbanales, a village near Barbastro, in the province of Aragon. He discovered an early disposition towards the arts and sciences, which was directed and stimulated by his near relation the celebrated painter Mengs. He entered into the military service at an early age, and in the capacity of officer passed to South America, and resided many years in different parts of the province of Buenos Ayres. Here he indulged his disposition for the study of zoology, and lived many years in some of the most sequestered parts, making collections and drawings of the various animals of that extensive country. The latter, with descriptions, were at length published at Paris in 1801. When he returned from South America, he was employed in the diplomatic department, and appointed ambassador to Pope Clement XII., by which he was brought into contact with Buonaparte, who was then occupied in the conquest of Italy. He became much attached to that conqueror, and obtained the appointment of ambassador to him from the court of Madrid. Amidst the shifting politics of that court, he seems to have been, in his latter years, the frequent victim of its indecision. He was at one time recalled suddenly, then banished to Barcelona, again appointed to the embassy, and again as suddenly deprived of it. These vexations affected him, and are said to have hastened his death. He died in Paris on the 26th of January 1804.

Azores
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B.

B.

B, the second letter, and first consonant, in all known alphabets, excepting the Ethiopic, where it occupies the ninth place. It is a labial and mute, representing the compression of the lips, and consequently incapable of being uttered or pronounced without the aid of a vowel, or a forcible expiration equivalent in effect to vocality. This letter has a near affinity to the other labials, with which, indeed, it is interchangeable according as the compression of the lips, which it primarily indicates, is modified by simultaneous expiration; and hence, although its ordinary power or effect is intermediate between the smooth and easy sound of P, and the rough aspirations of PH, F, and V, yet, in the articulation of many languages, it is habitually confounded with one or other of the letters of the same class, and, in the same language at different times, is frequently interchanged with its cog-

nate consonants. Thus βοσκω in Greek becomes *pasco* in Latin; γιλβος, *gilvus*; βρεμω, *fremo*; πυξος, *buxus*; αμφω, *ambo*; φαλανα, *balena*; θριαμβος, *triumphus*; and so in many other instances. Again, in Latin, the B of the olden time, and of the inscriptions, passes into V in a subsequent age; while, on the other hand, the P of the antique orthography is commuted into B in that of a more recent date. Hence we have *abavus* for *ababus*, *ave* for *abe*, *vixit* for *bixit*, *curvatus* for *curbatus*, and hundreds of other analogous instances in Gruter, Reinesius, Funccius, Gorius, Dempster, Fréret, and Lanzi, not to mention the *Monumenti degli Scipioni*, and similar works; while *Poplius* for *Publius*, *Poplicus* for *Publicus*, *Poplicola* for *Publicola*, are of frequent occurrence in the inscriptions and other elder monuments of the Latin language. This letter is also sometimes inserted in the middle of compound words for the sake of

Baal
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Baal-
zebub.

euphony, and to prevent the *hiatus* which would otherwise result from the concurrence of vowels, as *ambages*, *ambio*, *amburo*; it is servile in the dative and ablative plural of the third, fourth, and fifth declensions of Latin nouns, and in the præterimperfect and future tenses of the first and second conjugations; and it is interchangeable with P, F, and other letters, both in the composition and conjugation of a number of verbs.—In Hebrew, the name of the second letter, בֵּית, *bith* or *beth*, indicates the original hieroglyph to have represented a house or temple; whilst an abbreviated form of the figure has been employed to denote the initial sound of the word in the spoken language; a principle, also, upon which the ancient Egyptians appear to have constructed their phonetic alphabet, or used the symbolical characters of their complex system of writing, for representing the constituent sounds of proper names and of legends. A difference, however, will be observed between the two Phœnician forms of this letter; the first of which is that of a house or temple, whilst, in the second, another figure seems to have been combined with the first; from which it is probable that this people, the inventors of alphabetical characters or signs, had originally two hieroglyphs for the letter, and consequently two words by which it was named. This compound hieroglyph seems to have been composed of the *beth* or house, and of the head and horns of some animal placed over it, perhaps those of a בֹּקֶר, *boker*, ox or wild goat; which would explain the assertion of Hesiod, that the second or third letter of the Phœnicians was represented by an ox. At all events the Phœnician, reproduced in the early Greek, has served as the basis of most modern varieties in the languages of the west; and, amidst every change which time, accident, or caprice, has superinduced, it is still easy to detect and distinguish the elementary or primitive form. With regard to the different sounds or powers attached to the letter in modern languages, these have varied within the limits of its natural affinity; the Germans giving it the effect of P, the Spaniards, Gascons, and others, that of V; and the modern Greeks, sometimes that of V, but more frequently sounding it as we do F. The satirical epigrammatist who affirmed that, in Gascony, *bibere* is the same as *vivere*, stated a literal truth, in as far at least as the pronunciation of the words is concerned. In abbreviations B stands for *Badio*, *beatus*, *Beleno*, *bene*, *beneficiarius*, *berna* for *verna*, *biga*, *bivus* for *vivus*, *bixit* for *vixit*, *bonum*, *Brutus*, *burra*, *bustum*. (A.)

BAAL, the same as BEL or BELUS, an idol of the Chaldeans and Phœnicians or Canaanites. The word *Baal*, in the Punic language as well as in the Hebrew, signifies "lord" or "master," and doubtless meant the supreme Deity, the Lord and Master of the universe. Some learned men think that the Baal of the Phœnicians was the Saturn of the Greeks; others are of opinion that Baal was the Phœnician or Tyrian Hercules, a god of great antiquity in Phœnicia.

BAAL-BERITH, the god of the Shechemites. Bochart conjectures that Berith is the same as *Beroe*, the daughter of Venus and Adonis, who was given in marriage to Bacchus; and that she gave her name to the city of Berith in Phœnicia, of which she became afterwards the patron goddess.

BAAL-PEOR, *Baal-phegor*, or *Beel-phegor*, an idol of the Moabites and Midianites. We are told that "Israel joined himself to Baal-peor," and that Solomon erected an altar to this idol upon the Mount of Olives. Selden conjectures that Baal-peor is the same with Pluto; which he grounds upon these words of the Psalmist, "They joined themselves unto Baal-peor, and ate the offerings of the dead."

BAAL-ZEBUB, *Beel-zebub*, or *Belzebub*, the idol or god

of the Ekronites. In Scripture he is called the Prince of Devils. His name is usually rendered the "Lord of Flies," which, some think, was a mock appellation bestowed on him by the Jews. But Scaliger derives the name of this deity from *Baalim-zebahim*, which signifies the "Lord of Sacrifices;" the plural number (*Baalim*) being here, as in many other instances, used with a singular effect.

BABATAG, a city of the government of Silistria, in Turkey in Europe. It stands on the lake or estuary Rasim, which communicates with the Black Sea, and it is surrounded by mountains covered with woods. It is a large city, containing 10,000 inhabitants, amongst whom are many Jews and Greeks. It used to be the winter headquarters of the Turkish army during former wars with Russia. Long. 28. 32. E. Lat. 44. 55. N.

BABEL, a city and tower undertaken to be built by the whole human race soon after the Flood, and remarkable for the miraculous frustration of the attempt by the confusion of languages. As to the situation of ancient Babel, most authors are of opinion that it was exactly in the place where the celebrated city of Babylon afterwards stood. That it was in the same country, appears indisputably certain from Scripture; but that it was exactly in the same place, cannot be proved. Authors have been much divided about the motive by which the whole race of mankind were induced to join as one man in such an undertaking. Some have imagined that it was from the fear of a second deluge; others, that they knew beforehand that they were to be dispersed through all the different countries of the world, and built this tower in order to defeat the design of the Deity, because, having a tower of such vast height as they proposed, those who were at a distance could easily find their way back again. Others again suppose that the top of this tower was not to reach up to heaven, but to be consecrated to the heavens, that is, to the worship of the sun, moon, and stars, of the fire, air, &c., and other natural powers, as deities; and therefore that the true Deity interposed in order to prevent a total and irrecoverable defection. Less speculative persons think that the tower was erected as a fortress for the establishment of tyrannical power. As to the materials made use of in the building of this tower, the Scripture informs us that they were bricks, and slime or bitumen. According to an eastern tradition, three years were occupied in making the bricks, each of which was thirteen cubits long, ten broad, and five thick. Oriental writers say that the city was 313 fathoms in length and 151 in breadth; that the walls were 5533 fathoms high, and 33 in breadth; and that the tower itself was no less than 10,000 fathoms, or 12 miles high. Even St Jerome affirms, from the testimony of eye-witnesses, who, as he says, had examined the remains of the tower, that it was four miles high; and there are other statements still more extravagant. The only account of its dimensions which can be at all depended upon (supposing it to have been the same which afterwards stood in the midst of the city of Babylon, and round which Nebuchadnezzar built the temple of Belus) is that given under the article BABYLON.

BABELMANDEL, or BABELMANDEB, "the gate of mourning," a famous strait in the Indian Ocean, between the coast of Arabia Felix in Asia, and that of Adel and Zeila in Africa, at the entrance into the Red Sea. By some it is also called the Strait of Moka. It is narrow, being only seven miles wide, and difficult to navigate on account of the sand-banks. At the mouth of the strait is a small island called also *Babelmandel*, which is five miles in circumference, but barren and scarcely inhabited. Long. 44. 30. E. Lat. 12. 40. N.

BABENHAUSEN, a town and hereditary magistracy.

Babatag
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Baben-
hausen.

Baber
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Babylon.

belonging to the mediatized prince of Fugger-Babenhäusen, now a part of the circle of the Upper Danube, in the kingdom of Bavaria. The district comprehends four market-towns, ten feudal castles, and sixty-one villages, with 11,156 inhabitants. The town, the residence of the prince, is on the river Gunz, and contains, besides his castle, about 300 houses and 2000 inhabitants.

BABER, an island in the Eastern Seas, surrounded by some smaller ones. It is about 18 miles long by six in its average breadth, and is situated between the 130th and 131st degree of east longitude.

BABINGTON, GERVASE, bishop of Worcester, was born, according to Fuller, in Nottinghamshire; but in what year is uncertain. He was sent to Trinity College, Cambridge, of which he became a fellow; and, in 1578, he was incorporated master of arts at Oxford. He appears, however, to have made Cambridge the place of his residence, where he became an eminent preacher; and, having taken the degree of doctor of divinity, he was made domestic chaplain to Henry earl of Pembroke. In this station he is supposed to have assisted the countess in her translation of the Psalms. In 1588 he was installed prebend of Hereford, and in 1591 consecrated bishop of Landaff. In 1564 he was translated to the see of Exeter, and thence to Worcester in 1597. About this time, or soon after, he was made queen's counsel for the marches of Wales. He was a considerable benefactor to the library belonging to the cathedral of Worcester, where he was buried in May 1610, without a monument. The several historians who have mentioned this prelate agree in giving him the character of a learned and pious man. His works, consisting of notes upon the five books of Moses, an exposition of the creed, &c. were printed both in folio and quarto in 1615, and again in folio in 1637.

BABOON. See MAMMALIA *Index*.

BABUYANES, a group of small islands about 30 miles north of the island of Luzon, and generally considered the most northerly of the Philippines. They are mostly from 25 to 30 miles in circumference, and run out into many rocky islets. The principal productions are wax, ebony, bananas, cocoas, and plantains. They are a noted haunt of piratical vessels from Mindanao. Long. from 121. 15. to 122. 5. E. Lat. from 18. 58. to 19. 42. N.

BABYLON, the capital of the ancient kingdom of Babylonia or Chaldæa, situated about long. 44. 20. E. lat. 32. 30. N. Semiramis is said by some, and Belus by others, to have founded this city. But by whomsoever Babylon was founded, Nebuchadnezzar was the person who completed it, and made it one of the wonders of the world. The most famous works in and about the city were the walls, the temple of Belus, Nebuchadnezzar's palace, the hanging gardens, the banks of the river, the artificial lake, and the canals.

City described.

The city was surrounded with walls, eighty-seven feet in thickness, 350 feet in height, and 480 furlongs, or sixty of our miles, in compass. Such, at least, is the statement of Herodotus, who was himself at Babylon. Diodorus Siculus, however, diminishes the circumference of these walls very considerably, and takes somewhat from their height as given by Herodotus. It is observed, that those who make the height of these walls but fifty cubits, speak of them as they existed after the time of Darius Hystaspes, who had caused them to be greatly reduced. These walls formed a square, each side of which was 120 furlongs, or fifteen miles, in length; and they were built of large bricks cemented together with bitumen. The city was encompassed, without the walls, with a vast ditch filled with water, and lined with bricks on both sides; and, as the earth that had been dug out of it served to form the bricks, we may judge of the depth and largeness of the ditch from the

height and thickness of the walls. In the whole compass of the wall there were an hundred gates, that is, twenty-five on every one of the four sides, all formed of brass. Between each two of these gates, at proper distances, were three towers, and four more at the four corners of this great square, and three between every corner and the next gate on either side; and these towers were ten feet higher than the walls. But this is to be understood only of those parts of the walls where towers were needed for defence; for in some parts of them, which rested upon a morass and were inaccessible to an enemy, the labour and cost of such defences were spared. The whole number, then, of these towers amounted to no more than 250. From every one of the twenty-five gates on each side of this square there ran a straight street, extending to the corresponding gate in the opposite wall; whence the whole number of the streets must have been only fifty; but then they were each about fifteen miles in length, one half of them, or twenty-five, crossing the other twenty-five at right angles. Besides these whole streets, however, we must reckon four half streets, consisting of rows of houses facing the four inner sides of the walls. But these four half streets were properly the four sides of the city within the walls, and each of them was 200 feet broad, the whole streets being about 150 feet broad. By this intersection of the fifty streets the city was divided into 676 squares, every one of four furlongs and a half on the side, or two miles and a quarter in compass. Round these squares, on every side towards the streets, stood the houses, many of which were several stories in height, and adorned with all manner of embellishment; while the space within each of these squares was occupied by fields or gardens, either for pleasure or convenience.

A branch of the Euphrates divided the city into two parts, running through the midst of it from north to south; and over it, in the very middle of the city, was a bridge a furlong or rather more in length. This bridge is said to have been built with wonderful art, in order to supply a defect in the bottom of the river, which was all sandy. At its opposite ends were two palaces, namely, the old palace on the east side, and the new one on the west side of the river; the former of which occupied four of the squares above mentioned, and the latter nine. The temple of Belus occupied another of these squares.

The whole city stood in a large flat or plain, in a very fat and deep soil; that part or half of it situated on the east side of the river constituted the old city, and the other on the west was added by Nebuchadnezzar, while both were included within the vast square bounded by the walls already mentioned. The form of the whole was probably borrowed from Nineveh, which was also 480 furlongs in circuit. It is supposed that Nebuchadnezzar, who had destroyed the old seat of the Assyrian empire, intended that this new one should rather exceed it; and that in order to fill it with inhabitants, he transported thither vast numbers of captives from other countries.

According to the description of Herodotus, Babylon must have covered ten times as large a space as London. It is certain, however, that much of the ground was occupied with fields and gardens; and hence it was rather an inclosed district, with groups of buildings interspersed, than a city in the modern sense of the term.

One great work of Nebuchadnezzar was the temple of Temple Belus. But the wonderful tower connected with it was of Belus. built many ages before, and is supposed to have been the same structure with the tower of Babel. This tower is said by Herodotus to have been composed of eight pyramidal ones raised above one another, and to have been a furlong in height. The ascent to the top was by means of stairs on the outside passing round it. Until

Babylon. the time of Nebuchadnezzar, it is thought that this tower was the only temple of Belus; but that king made great additions to it by erecting vast edifices round it, in a square of two furlongs on every side, and a mile in circumference. On the outside of these buildings was a wall which inclosed the whole; and in this wall were several gates, all of solid brass, leading into the temple. In the temple thus enlarged were several images or idols of massive gold, and one of them, forty feet in height, is supposed to have been that which Nebuchadnezzar consecrated in the plains of Dura.—On the east side of the river stood the old palace of the kings of Babylon, which was four miles in circumference; and opposite to it, on the other side of the river, was the new palace built by Nebuchadnezzar, eight miles in circumference, and consequently four times as large as the old one.

Hanging gardens.

But nothing was more wonderful at Babylon than the hanging gardens, which Nebuchadnezzar formed in complaisance to his wife Amyte; who, being a Mede, and retaining a strong predilection for the mountains and forests of her own country, was desirous of having something like them at Babylon. They are said to have contained a square of four plethra, or 400 feet, on each side; and to have consisted of terraces raised one above another, and carried up to the height of the wall of the city, the ascent from terrace to terrace being by steps ten feet wide. The whole pile consisted of substantial arches upon arches, and was strengthened by a wall 22 feet thick surrounding it on every side. The floors on each of them were constructed in this order: first, on the tops of the arches was laid a bed or pavement of stones, sixteen feet long and four feet broad, over which was a layer of reeds mixed with a great quantity of bitumen; and this again was covered with two courses of bricks closely cemented together with plaster; while over all these were placed thick sheets of lead, on which was laid the earth or mould of the garden. This floorage was designed to retain the moisture of the mould, which was deep enough to give root to the largest trees, that were planted upon every terrace, together with a great variety of other vegetables pleasing to the eye. Upon the uppermost of these terraces was a reservoir, supplied with water from the river by means of an engine; and from this reservoir the gardens on the other terraces were irrigated, as occasion required.

Banks of the river, canals, &c.

The other works attributed to Nebuchadnezzar by Berossus and Abydenus, were the embankments on the side of the river, the artificial canals, and the great artificial lake said to have been formed by Semiramis. The canals were cut out on the east side of the Euphrates, to convey the waters of the river, when it overflowed its banks, into the Tigris, before they reached Babylon. The site of the lake was to the west of Babylon; and, according to the lowest computation, it was 40 miles square, 160 in compass, and in depth 35 feet, as Herodotus states. This lake was dug to receive the waters of the river, while the embankments were building on each side of it. But both the lake and the canal which led to it were preserved after that work was completed, being found of great use, not only to prevent all overflowings, but to keep water all the year, as in a common reservoir, to be let out on proper occasions by sluices for the improvement of the land.

The embankments were built of bricks and bitumen, on both sides of the river, to keep it within its channel, and extended on each side throughout the whole length of the city, and even farther, according to some, who reckon their longitudinal extent 160 furlongs, or twenty miles; whence it is concluded they must have commenced two miles and

a half above the city, and been continued an equal distance below it, the length of the city being no more than fifteen miles. Within the city they were raised from the bottom of the river, and were of the same thickness with the walls of Babylon itself. Opposite to each street, on either side of the river, was a brazen gate in the embankment wall, with stairs leading down from it to the river; and these gates were open by day, but shut by night.

The tower or temple stood till the time of Xerxes; but that prince, on his return from his Grecian expedition, having first plundered it of its immense wealth, demolished the whole, and laid it in ruins. Alexander, on his return to Babylon from his Indian expedition, proposed to rebuild it, and accordingly set 10,000 men to work to clear away the rubbish; but the work proved too herculean for such means, and his death happening soon after, a stop was put to all further proceedings in this design. After the death of the Macedonian conqueror, the city of Babylon began to decline apace; which was chiefly owing to the proximity of Seleucia, built by Seleucus Nicator, and peopled with 500,000 persons drawn from Babylon.

Such is the description we have received from ancient historians of the grandeur of this city. Many of the moderns, however, are of opinion that their accounts are greatly exaggerated. The remarks of Goguet on this subject are particularly deserving of attention, as embodying sound sense and judicious criticism. We come now to give some account of the ruins of Babylon as they are described by modern travellers.

Amongst all the remains of ancient grandeur, there are none perhaps which possess equal interest with the ruins of Babylon; none, except those of Egypt, which present so many striking images to the imagination, or carry back the mind into such a depth of antiquity. It happens fortunately that their site, through the learned investigations of Major Rennell, may be considered as completely fixed to the small district situated immediately to the north of the village called Hillah.¹ Its position on the Euphrates, the fountains of bitumen at Hit or Heet, the distance from the ascertained position of Seleucia and Ctesiphon, and the character of the surrounding country, combine in establishing this point beyond a doubt. The appellation of *ruins*, in its proper sense, cannot, however, be applied to the present remains of Babylon, which consist almost wholly of bricks, fragments, and rubbish, piled, as it were, in masses, and serving as quarries for the construction of new cities. In this condition, nevertheless, they have deservedly attracted the attention of modern travellers; and interesting notices have been successively given by Della Valle, Niebuhr, Ives, Otter, and Beauchamp. But the recent observations of Mr Rich, enlightened by the previous inquiries of Major Rennell, have been so much more careful and complete, that they nearly supersede all prior information. We shall therefore, in the first place, give a view of the objects which presented themselves to Mr Rich in traversing this celebrated ground; and then offer some remarks respecting those ancient edifices, of which these objects are to be considered as the remains.

Mr Rich commenced his observations at Hillah, and proceeded to the north, along the eastern bank of the Euphrates. After passing some smaller mounds, he came to a vast mass, 1100 yards in length and 800 in its greatest breadth, whilst its most elevated part rose 50 or 60 feet above the level of the plain. It consists almost wholly of earth formed from decomposed brick, and strewed with various species of fragments. The name of Amran is given to it from a tradition, seemingly unfounded, of a son of Ali having been buried in it. Then, after tra-

¹ Hillah is nine miles from Mohawil, and nearly forty-eight from Bagdad. (Rich's *Memoir on Babylon*.)

Babylon.

versing a valley 550 yards in length, and crossed by some smaller ruins, he came to the second grand mass, forming nearly a square of 700 yards every way. This part of the ruins is extremely interesting, containing several walls in a pretty entire state: these are eight feet thick, in some places ornamented with niches, in others strengthened by pilasters and buttresses. Some remains of painting and sculpture are still to be seen on them. The bricks are of the very finest kind, and cemented with lime. We may here observe that the city, as Major Rennell suspected, appears to have been built partly of burnt and partly of unburnt bricks. Three kinds of cement have also been used. The unburnt bricks are in general merely bound together with reeds or chopped straw, which are still found in great quantities. The burnt bricks are cemented, partly with bitumen, but more frequently with lime; a material, the use of which had escaped the notice of observers previous to Mr Rich. He states it to be much the most efficacious of any. Bricks cemented with bitumen could be easily separated; but where good mortar had been used, no power of art could detach them from the wall, without breaking them in pieces. Some parts of the edifice in question have been deeply excavated, with a view to the removal of the bricks; but the workmen have been intimidated in consequence of the rubbish having fallen in and buried some of their number; and they have given up the walls, on account of the extreme tenacity with which they are cemented. This edifice is called by the natives the *Kasr* or palace.

A mile to the north of the *Kasr*, and about half a mile from the river, is a mass equally remarkable. It is an irregular oblong, the sides being respectively 200, 219, 182, and 136 yards in length; and the greatest elevation 141 feet. Near the summit of the western side appears a low wall, built of unburnt bricks, cemented with reeds and straw. The summit is covered with heaps of rubbish, and with innumerable fragments of pottery, brick, bitumen, pebbles, vitrified brick, and even shells, bits of glass, and mother of pearl. There are many dens of wild beasts in this part of the ruins, and most of the cavities are filled with bats and owls. As there appeared a niche or recess near the summit of the northern face, Mr Rich caused it to be dug into. The workmen successively extracted two wooden coffins, containing skeletons in high preservation. He was of opinion that the whole passage, whatever might be its extent, would have proved to have been occupied in the same manner.

This mass, denominated the *Mujelibé*, being the most elevated part of these remains, has been considered by most travellers as the Tower of Belus, which formed one of the two grand features in the wonders of ancient Babylon. The other was the palace, with its hanging gardens; and this had been clearly pointed out by ancient authorities as on the side opposite to the tower of Belus. The tower then being on the eastern, the palace was to be sought on the western bank of the river. With the exception, however, of a slight notice collected by D'Anville, modern travellers had given no information of any ruins situate in that quarter. Major Rennell very properly pointed out this as a grand object of investigation for future inquirers. Mr Rich, on reaching the summit of the *Mujelibé*, whence he commanded an extensive view across the river, was much surprised at discovering no trace of any ruins whatever. Not satisfied with this distant view, he crossed and carefully surveyed the ground, but could discern only some mounds of small dimensions, which conveyed no idea of the immense structures of which he was in search. Before leaving this neighbourhood, however, he went to visit a tower, which had been imperfectly observed by Niebuhr, about six miles south-

west of Hillah, and beyond the site assigned to ancient Babylon. Our traveller, who had formed no high expectations from this object, was struck with the utmost amazement at its magnitude and grandeur, which decidedly surpassed any thing he had yet witnessed among these interesting remains. It consists of a mound of an oblong figure, 762 yards in circumference; rises in a conical form to the height of 198 feet; and has on its summit a solid pile of brick 37 feet high, diminishing in thickness to the top. The bricks are of the finest description, with inscriptions on them, and so well cemented with lime that it is nearly impossible to extract one of them entire. This ruin is called by the Arabs the *Birs Nimrod*. Every thing remarkable is by them ascribed to Nimrod; but the meaning of the term *Birs* seems unknown even to themselves. By the Jews it is called Nebuchadnezzar's Prison. At a trifling distance to the east is a mound equal in elevation to the *Kasr*, and all around are traces of ruins to a considerable extent.

Mr Rich having thus described these ruins, begins very cautiously to form conjectures respecting their origin and nature. At the first sight of the *Birs Nimrod* he had involuntarily exclaimed, that if the situation rendered it possible, this certainly must be the tower of Belus. Besides its extraordinary magnitude, there is some appearance of its being built in stages, as described by ancient authors; and the mound on the east might correspond to the temple, which occupied part of the quadrangular inclosure that surrounded the tower. After considering these circumstances, Mr Rich is led on to inquire whether it be so certain as is generally supposed that the tower of Belus must be found on the eastern side of the river, and the palace and hanging gardens on the western. But after some acute remarks his path becomes entangled, and he is obliged to stop without arriving at any satisfactory distribution of the objects which had fallen under his observation. The subject is certainly involved in much darkness and uncertainty; but as it is of considerable interest, we shall present our readers with such observations as its consideration has suggested to us.

It is stated by ancient writers, in the most positive and circumstantial manner, that the palace, with its grand appendage of hanging gardens, was situate upon, or very near to the river, whence, indeed, the gardens were artificially watered. Now, modern Babylon presents, near to the river, no ruins of any magnitude, except those on its eastern bank,—the *Amran*, *Kasr*, and *Mujelibé*. It seems unquestionable, therefore, that these, if any, must be the remnant of those immense structures. Then, following Herodotus, we must look for the tower of Belus on the western side of the river. But here we are crossed by the statement of Diodorus, to which Mr Rich does not seem to have fully adverted. That author reports that there were *two* palaces built on the opposite sides of the Euphrates, of which by far the most extensive and magnificent was that on the western bank. This Major Rennell naturally infers to be the one which other writers call *the palace*. But it deserves notice that Diodorus is the only authority for there being *two* palaces. Herodotus and Curtius, the former an eyewitness, mention only one, and evidently entertain no idea that any more existed. It seems also quite unaccountable, that while inferior structures exhibit vast piles of ruins, this western palace, which must have been the grandest and most extensive of all, should not have left the slightest trace of its existence. It may therefore deserve consideration whether Diodorus, who wrote only from hearsay, might not have been deceived, by varying accounts of one palace, and thus led to form the idea that there were two. The striking similarity in his two descriptions, as to situation, plan, and

Babylon.

Babylon. ornament, somewhat favours the conjecture. We are sensible that it is a bold one; but can only say, that without it, the aspect of modern Babylon is wholly inexplicable; for it seems quite ascertained that there are no ruins of any magnitude close to the river, unless on one side, which is the eastern. It may not be amiss, therefore, to follow out the supposition, and to inquire how far, by its aid, the ancient and the recent descriptions can be brought to accord.

Ancient Babylon consisted of an immense square, divided by the Euphrates into two nearly equal parts. It is distinctly stated by Herodotus, that the palace and tower were in divisions opposite to each other. If, then, the ruins on the eastern side be the palace, we must look to the western for the tower. And there we find the Birs Nimrod, a stupendous pile, the dimensions and character of which are precisely such as the tower, in a state of total dilapidation, might have been expected to exhibit. Yet, to its really being the remains of that edifice, the objections are formidable. First, its distance of nearly ten miles from the Mujelibé would, to include it within the city, require an extension even of the vast limits assigned by Major Rennell. But it is certain that the extent of Babylon was immense; that it rather resembled an inclosed district than a city. A great part of its area was under cultivation; and it has even been asserted, that the produce raised within the walls could, in case of siege, support its immense population. Without resting on the authority of Herodotus, although it be confirmed by Pliny, even the dimensions of Strabo, reckoned according to his own estimate of the stadium, would give upwards of eleven miles to each side of the square. But it is supposed that the palace and tower must each be in the centre of their respective divisions; an arrangement certainly incompatible with the actual situation of the ruins. The expression of Herodotus, no doubt, is *εν μεσση*, in the middle; which Major Rennell has translated *centre*. We doubt much, however, if this expression can be understood in so precise and mathematical a sense. It is familiarly said that a building is in the middle or heart of a city, when it is completely inclosed within it, and surrounded by its buildings, even though it may approach to one of its extremities. No one, we suppose, would hesitate to say that Pall-mall or Westminster Abbey was in the middle of London. Such, it appears to us, might be the present meaning, especially since the palace, being upon the river, could not, geometrically speaking, be in the middle of its division. The Kasr above described seems pretty exactly what we should expect in the ornamented and inhabited part of the palace. The Mujelibé, Mr Rich conceives, might be the hanging gardens. We would suggest the mound of Amran as a more probable situation, from its vicinity both to the river and to the palace, while the Mujelibé is at an inconvenient distance from both. This last structure, from Mr Rich's observations, seems decidedly to suggest the idea of a royal sepulchre. Of such structures, several are mentioned in Babylonish history, particularly that of Ninus, said to have been built *within* the palace, and of extraordinary elevation. (Diod. lib. ii. cap. 7.)

Since the above was written and published in the Supplement to the last edition, we have had an opportunity of consulting Mr Rich's second memoir. It does not contain many additional facts; but the examination made on this occasion tended strongly to confirm his first conjecture, that the Birs Nimrod is the remains of the tower of Belus. "The masonry," says Mr Rich, "is infinitely superior to any thing I have ever seen; and leaving out of the question any conjecture relative to the original destination of this ruin, the impression made by a sight of

it is, that it was constructed in receding stages, and faced with fine burnt bricks, having inscriptions on them, laid in a very thin layer of lime cement; and that it was reduced by violence to its present ruined condition. The upper stories have been forcibly broken down, and fire has been employed as an instrument of destruction, though it is not easy to say precisely how or why." This result is to us gratifying, since he appears to have come to the same conclusion which, as above expressed, we had drawn from the facts stated in the first memoir. Mr Rich indeed adds, that just on closing this memoir, he received at Bagdad a copy of our volume, and expresses in very handsome terms his satisfaction at the coincidence. Mr Buckingham's more recent observations tend altogether to confirm Mr Rich's views. On examination he discovered traces of four stages in this pile; and admitting the original height to be a stadium, as Herodotus states, the stadium to be 500 feet, and the stages or stories to be equal, it will follow that vestiges of four stories should exist within the existing elevation of 235 feet.

Very recently, however, Captain Mignan has published the result of a most careful and meritorious survey of these ruins, with interesting representations of their present condition. This writer, supported by the high authority of Major Rennell, adopts an opinion decidedly opposite. According to him, the Birs Nimrod has no concern whatever with ancient Babylon. The tower of Belus, the most memorable among its structures, is, according to him, the edifice above described, called the Mujelibé. To us, however, all the facts stated by this traveller, and his representations of these remains, which are the best yet given to the public, appear to refute his own opinion, and confirm that which we had previously formed. Let us take a comparative view of these two structures, which contend for the honour of representing the grandest of Babylonian monuments. The Mujelibé is an irregular oblong, without any correspondence as to dimensions, only about half the height of its rival ruin, and composed almost entirely of the inferior material of sun-dried bricks. The Birs Nimrod, on the contrary, is of a form manifestly pyramidal, as the tower is described to have been. It is coated with the very finest materials employed in the construction of Babylon, is much more elevated than any of the other remains, and bears evident marks of having formerly risen considerably higher. There are also manifest traces of its having been built in successive stages. The one, therefore, presents in itself every mark of having been the tower of Belus, the other presents none. Our opinion is much strengthened by the observations of Captain Mignan himself, that this structure, instead of standing solitary, as has been generally supposed, is surrounded by extensive ranges of ruins, bearing in their shattered fragments every mark of ancient importance. There hence appears no room to doubt that this quarter was completely included within the vast circuit of ancient Babylon. When we learn also from Mr Buckingham that the ground to the south of this structure is covered with extensive marshes, and even lakes, and find the ancient authorities describing the approach to the south-west gate of Babylon to be through obstacles of this very description, the conclusion that the Birs was within the limits of Babylon seems no longer to admit of doubt. The idea of Captain Mignan, that it was an advanced bastion of defence, seems not at all to agree with its extraordinary elevation, its superior workmanship, and the fine materials of which it is composed.

Both Buckingham and Mignan observed a long, hollow space, damp, and sometimes marshy, through which, instead of its present course, it might be supposed that the Euphrates anciently flowed. We do not very much ad-

Babylonia. mire the system of supposing changes in the grand features of nature, with the view of adapting them to modern hypotheses. That a canal, perhaps artificial, may have anciently been conducted through this hollow, seems probable enough, though by no means established; but the breadth of the supposed channel, stated by Captain Mignan at not more than 160 yards, seems quite insufficient to contain the main body of the river, which, from his plan, appears to occupy about three times that space.

Mr Rich collected sundry antiquities among the ruins. These were bricks or pieces of hardened clay, gems, slabs of stone, and bits of brass with engraved figures or characters. But no Babylonian coins or darics have been discovered at Hillah. (See *Memoirs on the Ruins of Babylon*, by Claudius James Rich, Esq. Lond. 1815, 1818, 8vo.; Buckingham's *Travels in Mesopotamia*; Mignan's *Travels in Chaldea*, 1829.)

BABYLONIA, or CHALDÆA, a kingdom of Asia, and the most ancient in the world, being founded by Nimrod, the grandson of Ham, who also, according to the Bible, founded Nineveh, the capital of the kingdom of Assyria. The country was bounded on the north by the desert part of Mesopotamia, on the east by the Tigris, on the south by the Persian Gulf, and on the west by the Arabian desert. The confines of the kingdom, however, were at times much more extensive.

Passing over the early portion of Babylonian history, which is obscure and doubtful, we shall limit ourselves to a short account of the events which terminated in the subversion of the kingdom.

War had been begun between the Medes, Persians, and Babylonians, in the reign of Neriglissar, the father of Nabonadius, which had been carried on with very bad success on the side of the Babylonians. Cyrus, who commanded the Median and Persian army, having subdued the several nations inhabiting the great continent from the Ægean Sea to the Euphrates, bent his march towards Babylon. Nabonadius, hearing of his march, immediately advanced against him with an army. In the engagement which ensued, the Babylonians were defeated; and the king, retreating to his metropolis, was blocked up and closely besieged by Cyrus. The reduction of this city was no easy enterprise. The walls were of a prodigious height, the number of men employed to defend them was great, and the place was stored with all sorts of provisions for twenty years. Cyrus, despairing of being able to take such a city by storm, caused a line of circumvallation to be drawn quite round it, with a large and deep ditch; reckoning that if all communication with the country were cut off, the besieged would be obliged to surrender through famine. That his troops might not be too much fatigued, he divided his army into twelve bodies, appointing each body its month to guard the trenches; but the besieged, looking upon themselves as out of all danger by reason of their high walls and magazines, insulted him from the ramparts, and looked upon all the trouble he gave himself as so much unprofitable labour.

After Cyrus had spent two whole years before Babylon, without making any progress in the siege, he at last thought of the following stratagem, which put him in possession of it. He was informed that a great annual solemnity was to be held at Babylon, and that the inhabitants on that occasion were accustomed to spend the whole night in drinking and debauchery. This he therefore thought a proper time for surprising them; and accordingly sent a strong detachment to the head of the canal leading to the great lake, with orders, at a certain time, to break down the great bank which was between the lake and the canal, and to turn the whole current into the lake. At the same time he stationed one body of

troops at the place where the river entered the city, and another where it came out; ordering them to march in by the bed of the river as soon as they should find it fordable. Towards the evening he opened the head of the trenches on both sides of the river above the city, that the water might discharge itself into them; by which means, and the breaking down of the great dam, the river was soon drained. Then the two bodies of troops above-mentioned, according to their orders, entered the channel, the one commanded by Gobryas and the other by Gadates; and finding the gates all left open in consequence of the disorders of that riotous night, they penetrated into the very heart of the city without opposition, and meeting, according to agreement, at the palace, they surprised the guards and cut them in pieces. Those who were in the palace opening the gates to know the cause of this confusion, the Persians rushed in, took the palace, and killed the king, who came out to meet them sword in hand. Thus an end was put to the Babylonian empire; and Cyrus took possession of Babylon for one called in Scripture Darius the Mede, most probably Cyaxares II., uncle to Cyrus. From this time Babylonia never was erected into a distinct kingdom, but has always followed the fortune of those great conquerors who at different times have appeared in Asia. It is now subject to the Turks.

Of the manners, customs, and institutions of the Babylonians, and of the nature of their country, a very clear account has been given by M. Sabbathier.

"As all the nations under the dominion of Cyrus, beside the ordinary tributes, were obliged to maintain him and his army, the monarch and his troops were supported by all Asia. The country of Babylon alone was obliged to maintain him four months of the year; its fertility, therefore, yielded a third of the produce of Asia. The government of this country, which the Persians termed *satrapy*, was richer and more extensive than any of the rest. It maintained for the king, besides the war-horses, a stud of 800 stallions and 16,000 mares. So great a number of Indian dogs were likewise bred in this province for the king, that four of its cities kept those animals; and in return, they were exempted from all taxes and tributes.

"It rained very seldom in this country, according to Herodotus. The earth was watered by the river, which was here diffused by human industry, as the Nile is over Egypt by nature; for all the country of Babylon was divided by canals, the greatest of which was navigable, and flowed from south to north, from the Euphrates to the Tigris. In short, it was one of the finest countries for corn in the world; but for producing trees, the fig-tree, the vine, and the olive, it was not famous. It was so luxuriant in grain, that it commonly yielded a hundred times more than what was sown; and in good years it yielded three hundred times more than it received. The leaves of its wheat and barley were four inches broad. 'Though I know,' says Herodotus, 'that the millet and the sesame of that country grow to the size of trees, I will not describe them particularly, lest those who have not been in Babylonia should think my account fabulous.'

"They had no oil but what they made from Indian corn. The country abounded with palm-trees, which grew spontaneously; and most of them bore fruit, of which the inhabitants made bread, wine, and honey. They cultivated these trees and their fig-trees in the same manner. Some of them, as of other trees, the Greeks called *male* ones. They tied the fruit of the male to the trees which bore dates; that the musquitto, leaving the male, might cause the date to ripen, by penetrating it; for without that assistance it did not come to maturity. Musquittoes bred in the male palms as in the wild fig-trees.

Babylonia. "But we must not here omit to give an account of the peculiar and surprising construction of their boats of skins, in which they sailed along the river to Babylon. These boats were invented by the Armenians, whose country lay north from Babylonia. They made them with poles of willow, which they bent, and covered with skins; the bare side of the skins they put outwards; and they made them so tight that they resembled boards. The boats had neither prow nor stern, but were of a round form like a buckler. They put straw on the bottom. Two men, each with an oar, rowed them down the river, laden with different wares, but chiefly with palm wine. Of these boats some were very large and some very small: the largest carried the weight of 500 talents. There was room for an ass in one of their small boats; they put many into a large one. When they had unloaded, after their arrival at Babylon, they sold the poles of their boats and the straw, and loading their asses with the skins, returned to Armenia; for they could not sail up the river, its current was so rapid. For this reason they made their boats of skins instead of wood; and on their return to Armenia with their asses, they applied the skins to their former use.

"As to their dress, they wore a linen shirt, which came down to their feet. Over it they wore a woollen robe; their outer garment was a white vest. Their shoes resembled those of the Thebans. They let their hair grow. On their heads they wore a turban. They rubbed their bodies all over with fragrant liquors. Each man had a ring on his finger, and an elegant cane in his hand, with an apple at the top, or a rose, a lily, or an eagle, or some other figure; for they were not suffered to use canes without devices.

"With regard to their policy, Herodotus thinks that their best law was one which the Heneti, an Illyrian people, likewise observed in every town and village. When the girls were marriageable, they were ordered to meet in a certain place, where the young men likewise assembled. They were then sold by the public crier: but he first sold the most beautiful one. When he had sold her at an immense price, he put up others to sale, according to their degrees of beauty. The rich Babylonians were emulous to carry off the finest women, who were sold to the highest bidders. But as the young men who were poor could not aspire to have fine women, they were content to take the ugliest with the money which was given them; for when the crier had sold the handsomest, he ordered the ugliest of all the women to be brought, and asked if any one was willing to take her with a small sum of money. Thus she became the wife of him who was most easily satisfied; and thus the finest women were sold, and from the money which they brought, small fortunes were given to the ugliest, and to those who had any bodily infirmity. A father could not marry his daughter as he pleased; nor was he who brought her allowed to take her home, without giving security that he would marry her. But, after the sale, if the parties were not agreeable to each other, the law enjoined that the purchase-money should be restored. The inhabitants of any of their towns were permitted to marry wives at these auctions. Such were the early customs of the Babylonians.

"But they afterwards made a law, which prohibited the inhabitants of different towns from intermarrying, and by which husbands were punished for treating their wives ill. When they had become poor by the ruin of their metropolis, fathers used to prostitute their daughters for gain. There was a sensible custom among the Babylonians, worthy to be related. They brought their sick into the forum, to consult those who passed on their diseases; for they had no physicians. They asked those who approached the sick, if they had ever had the same

distemper; if they knew any one who had had it; and Babylonian how he was cured. Hence, in this country, every one who saw a sick person was obliged to go to him and inquire into his distemper.

"They embalmed their dead with honey, and their mourning was like that of the Egyptians.

"There were three Babylonian tribes who lived only upon fish, and who prepared them in the following manner: they dried them in the sun, and then beat them in a mortar to a kind of flour, which, after they had sifted through linen, they baked into rolls.

"The Babylonians at first worshipped only the sun and the moon; but they soon multiplied their divinities. They deified Baal, Bel, or Belus, one of their kings, and Merodach-Baladan. They also worshipped Venus under the name of *Mylitta*. She and Belus were the principal deities of the Babylonians. They counted their day from sunrise to sunrise. They solemnized five days of the year with great magnificence, and almost the same ceremonies with which the Romans celebrated their Saturnalia.

"The Babylonians were very much addicted to judicial astrology. Their priests, who openly professed that art, were obliged to commit to writing all the events of the lives of their illustrious men; and on a fancied connection between those events and the motions of the heavenly bodies the principles of their art were founded. They pretended that some of their books, in which their historical transactions and revolutions were accurately compared with the courses of the stars, were thousands of years old. This assertion of their judicial astrologers we may reasonably dispute; but that their astronomers had made a long series of observations, is incontestably true. It is certain that some of these were extant in the days of Aristotle, and that they were older than the empire of the Babylonians." (See *History of ASTRONOMY*.)

BABYLONIAN, **BABYLONIUS**, is used by some ancient writers to signify astrologer, or any thing relating to astrology. Hence *Babylonia cura* means the art of casting nativities; and *numeri Babylonii*, the computation of astrologers.

BABYLONICA TEXTA, a rich sort of weavings or hangings, denominated from the city Babylon, where the art of interweaving divers colours in hangings or tapestry was first practised. Hence also Babylonian garments, Babylonian skins, Babylonian carpets, housings, &c.

BACCHÆ, in *Antiquity*, the priestesses of Bacchus, who celebrated the *orgia* or mysteries of that god. The word was also used for the ivy crowns or garlands worn by the priests of Bacchus at the Dionysiac festivals.

BACCHANALIA, feasts celebrated in honour of Bacchus by the ancients. The two most remarkable were denominated the greater and lesser. The lesser, called *Lenæa*, from a word signifying a wine-press, were held in the open field about autumn; the greater, called *Dionysia*, from one of the names of Bacchus, were celebrated in the city about the spring time.

BACCHIC, something relating to the ceremonies of Bacchus. The celebrated intaglio called Michael Angelo's ring, is a representation of a Bacchic feast.

BACCHIC Song is sometimes used for a *chanson à boire*, or composition calculated to inspire jollity; but in a more proper sense it is limited to a dithyrambic ode or hymn.

BACCHIUS, a follower of Aristoxenus, supposed by Fabricius to have been tutor to the emperor Marcus Antoninus, and consequently to have lived about A. D. 140. He wrote in Greek a very short introduction to music, in the form of dialogue, which Meibomius has published with a Latin translation. The dialogue was first published in the original by Mersennus, in his commentary on the first six chapters of Genesis.

Babylonian
Bacchius.

Bacchus
||
Baccio.

BACCHUS, the god of wine, with whose fabulous characteristics and adventures every school-boy is acquainted. This divinity is seldom named in modern times, except as the supposititious patron of sensuality and excess; but he was regarded in a more respectable light by the ancients, who worshipped him in different countries under various appellations. It is natural to suppose that the Greeks and Romans ascribed to the Bacchus whom they worshipped the several actions and attributes of the many divinities known by that and by other equivalent appellations in different countries. It is evident, however, that antiquity distinguished two divinities by the title of Bacchus, namely, him of Egypt, the son of Ammon, commonly known by the name of Osiris; and the Bacchus of Thebes in Bœotia, the son of Jupiter and Semele.

With regard to the dithyrambics which gave birth to dramatic representations, Dr Burney is of opinion that they are as ancient as the worship of Bacchus in Greece; and there is little doubt that the ceremonies observed at the celebration of his mysteries gave rise to scenic or theatrical representations in that country. Many of the most splendid exhibitions on the stage, both at Athens and at Rome, were performed at the festivals of this divinity; and hence all those who were employed in them, whether in singing, dancing, or reciting, were called servants of Bacchus.

BACCHYLIDES, a famous Greek poet, was the nephew of Simonides, and flourished about 450 years before Christ. He wrote Odes, Hymns, and Epigrams, of which there are some fragments in the first volume of Brunck's *Analecta*.

BACCIO, or **BACCIUS**, **ANDREW**, a celebrated physician of the sixteenth century, born at St Elpideo. He practised physic at Rome with great reputation, and was first physician to Pope Sixtus V. The most scarce and valuable of his works are the following:—1. *De Thermis*; 2. *De Naturali Vinorum Historia, de Vinis Italiae, et de Conviviis Antiquorum*; 3. *De Venenis et Antidotis*; 4. *De Gemmis ac Lapidibus Pretiosis*.

BACCIO, *Fra. Bartolomeo*, called *Barteleme di S. Marco*, a celebrated historical and portrait painter, born at Savignano, near Florence, in 1469, was a disciple of Cosimo Rosselli; but his principal knowledge of the art was derived from Leonardo da Vinci. He understood the true principles of design better than most masters of his time; and being also a considerable painter in perspective, Raphael had recourse to him, after quitting the school of Perugino, and, under his direction, studied the art of managing and uniting colours, as well as the rules of perspective. Some years after the departure of Raphael from Florence, Baccio visited Rome; and by the observations he made on the antiques and the works of Raphael, which were then the admiration of the whole world, he improved greatly, and manifested his acquired abilities by a picture of St Sebastian, which he finished at his return to Florence. This was so well designed, so naturally and beautifully coloured, and so strongly expressive of suffering and agony, that it was found necessary to remove it from the place where it had been exhibited, in the chapel of a convent, in consequence of the too powerful impression it had made on the imaginations of many women who beheld it. Baccio was very laborious, and made nature his perpetual study; his designs were distinguished for correctness and purity, his figures had a great deal of grace, and his colouring was admirable. He is usually accounted the inventor of the machine called a layman by the artists, and which to this day is in general use among the gentlemen of the pallet and brush. Upon it he placed his draperies, to observe with greater exactness their natural dependence and more elegant convolutions. There is a

capital picture of the Ascension, by Baccio, in the Florentine collection. He died in 1517.

BACHA, a city, chief of the bailiwick of the same name, containing 4162 inhabitants. It stands on the river Werra, in the duchy of Saxe Weimar, and contains a population of 1820 persons.

BACHELOR, or **BATCHELOR**, a common term for a man not married, or who is yet in a state of celibacy. The Roman censors frequently imposed fines on bachelors. Dionysius of Halicarnassus mentions an old constitution, by which all persons of full age were obliged to marry. But the most celebrated law of this kind was that made under Augustus, called the *Lex Julia de Maritandis Ordinibus*, by which bachelors were made incapable of taking legacies or inheritances by will, unless from their near relations. By the laws of Lycurgus bachelors were branded with infamy, and excluded from all offices civil and military, nay even from the shows and public sports. At certain feasts they were exposed to public derision, and led round the market-place. In the canon law we find injunctions on bachelors, when arrived at puberty, either to marry, or to turn monks and profess chastity in earnest.

BACHELOR was anciently a denomination given to those who had attained to knighthood, but wanted the number of vassals sufficient to entitle them to have their banner carried before them in the field of battle; or who, being of the order of bannerets, were not yet of age to display their own banner, and consequently obliged to march to battle under the banner of another. Bachelor was also a title given to young cavaliers, who having made their first campaign, received the military girdle accordingly; and it further served to distinguish him who had overcome an adversary in a tournament the first time he had ever engaged.

Knights-BACHELORS, the most ancient, but the lowest, order of knights in England, known by the name of *knights* only. They are styled *knights-bachelors*, either, according to some, as denoting their degree, *quasi* "*bas chevaliers*;" or, according to others, because this title does not descend to their posterity. Knights are called in Latin *equites aurati*; *aurati*, from the gilt spurs they wore, and *equites*, because they always served on horseback; for it is observable that almost all nations call their knights by some appellation derived from a horse.

BACHELORS, in universities, are persons who have taken the first degree in the liberal arts and sciences. See **DEGREES**, **ACADEMICAL**.

BACHIAN, one of the Molucca islands, about fifty-four miles in length by twenty in breadth, with an isthmus in the centre which widens towards each end. It is separated, by a narrow channel called the Strait of Patientia, from the island of Gilolo. It yields gold dust, sago, fruits, and the best cloves of the Moluccas. The inhabitants are Malay Mahomedans. Long. 127. 33. E. Lat. 1. 0. S.

BACHMUT, a circle in the European Russian government of Catherinoslav. It is very extensive, including within it a very large portion of the steppes, which are destitute of wood and scantily supplied with water, but feed great numbers of sheep and oxen. The chief town, of the same name, contains about 5000 inhabitants, who are great dealers in and breeders of horses. Long. 38. 3. E. Lat. 48. 32. N.

BACKGAMMON, an ingenious game played with dice, upon a table, by two persons. The table is divided into two parts, upon which there are twenty-four black and white spaces, called *points*. Each adversary has fifteen men, black and white, to distinguish them, and they are disposed of in the following manner: Supposing the game to be played in the right-hand table, two are placed upon the ace point in the adversary's table, five upon the six

Bacha
||
Backgammon.

Backgammon. point in the opposite table, three upon the cinque point in the hithermost table, and five on the six point in the right-hand table. The grand object in this game is for each player to bring the men round into his right-hand table, by throwing with a pair of dice those throws that contribute towards it, and at the same time to prevent the adversary doing the like. The first best throw upon the dice is esteemed aces, because it stops the six point in the outer table, and secures the cinque in the thrower's table; so that the adversary's two men upon the thrower's ace point cannot get out with either quatre, cinque, or six. This throw is an advantage often given to the antagonist by the superior player. When he carries his men home in order to lose no point, he is to carry the most distant man to his adversary's bar point, that being the first stage he is to place it on; the next is six points farther, viz. in the place where the adversary's five men are first placed out of his tables; and he must go on in this method till all his men are brought home except two, when by losing a point he may often save the gammon, by throwing two fours or two fives. When a hit is only played for, he should endeavour to gain either his own or adversary's cinque point; and if that fails by his being hit by the adversary, and he finds him farther advanced than himself, in that case he must throw more men into the adversary's tables, which is done in this manner: He must put a man upon his cinque or bar point; and if the adversary neglects to hit it, he may then gain a forward game instead of a back game. But if the adversary hits him, he should play for a back game; and then the greater number of men which are taken up makes his game the better, because by these means he will preserve his game at home. He should then endeavour to gain both his adversary's ace and trois points, or his ace and deuce points, and take care to keep three men upon the adversary's ace point, that in case the latter hits him from thence, that point may remain still secure to himself. A back game should not be played for at the beginning of a set, because it would be a great disadvantage, the player running the risk of a gammon to win a single hit. The subsequent calculations will show the odds of entering a single man upon any certain number of points. Upon two dice there are thirty-six chances, and upon these chances the following points, viz.

	Points.
2 Aces	4
2 Deuces	8
2 Trois	12
2 Fours	16
2 Fives	20
2 Sixes	24
6 and 5 twice	22
6 and 4 twice	20
6 and 3 twice	18
6 and 2 twice	16
6 and 1 twice	14
5 and 4 twice	18
5 and 3 twice	16
5 and 2 twice	14
5 and 1 twice	12
4 and 3 twice	14
4 and 2 twice	1
4 and 1 twice	10
3 and 2 twice	10
3 and 1 twice	8
2 and 1 twice	6

Divide by 36)294(8

This proves, that upon an average the player has a right to 288
8 points each throw 6

The chances upon two dice calculated for backgammon are as follow:

2 Sixes	1
2 Fives	1
2 Fours	1
2 Trois	1
2 Deuces	1
† 2 Aces	1
6 and 5 twice	2
6 and 4 twice	2
6 and 3 twice	2
6 and 2 twice	2
† 6 and 1 twice	2
5 and 4 twice	2
5 and 3 twice	2
5 and 2 twice	2
† 5 and 1 twice	2
4 and 3 twice	2
4 and 2 twice	2
† 4 and 1 twice	2
3 and 2 twice	2
† 3 and 1 twice	2
† 2 and 1 twice	2

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As it may seem difficult to find out by this table of thirty-six chances what are the odds of being hit upon a certain or flat die, let the following method be pursued. The player may observe in the table that the chances marked thus † are,

† 2 aces	1
† 6 and 1 twice	2
† 5 and 1 twice	2
† 4 and 1 twice	2
† 3 and 1 twice	2
† 2 and 1 twice	2

Total, 11

When deducted from.....36

There remains.....25

From which it appears that it is 25 to 11 against hitting an ace upon a certain or flat die. And this method holds good with respect to any other flat die. For example, what are the odds of entering a man upon 1, 2, 3, 4, or 5 points?

Answer.

To enter it upon	for	against	for	agt.
1 point is	11 to 25	or about	4 to 9	
2	20 ... 16	.....	5 ... 4	
3	27 ... 9	.....	3 ... 1	
4	32 ... 4	.....	8 ... 1	
5	35 ... 1	.....	35 ... 1	

The following table shows the odds of hitting with any chance, in the reach of a single die.

To hit upon	for	against	for	agt.
1 is	11 to 25	or about	4 to 9	
2 ...	12 ... 24	.....	1 ... 2	
3 ...	14 ... 22	.....	2 ... 3	
4 ...	15 ... 21	.....	5 ... 7	
5 ...	15 ... 21	.....	5 ... 7	
6 ...	17 ... 19	.....	8½ ... 9½	

The odds of hitting with double dice are as follow:—

To hit upon	for	against	for	agt.
7 is	6 to 30	or about	1 to 5	
8 ...	6 ... 30		1 ... 5	
9 ...	5 ... 31		1 ... 6	
10 ...	3 ... 33		1 ... 11	
11 ...	2 ... 34		1 ... 17	
12 ...	1 ... 36		1 ... 35	

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How to find out the odds of being hit upon a six, by the table of thirty-six chances.

2 Sixes.....	1
2 Trois.....	1
2 Deuces.....	1
6 and 5 twice.....	2
6 and 4 twice.....	2
6 and 3 twice.....	2
6 and 2 twice.....	2
6 and 1 twice.....	2
5 and 1 twice.....	2
4 and 2 twice.....	2
	<u>17</u>
Which deducted from.....	36
There remains.....	19

By which it appears to be 19 to 17 against being hit upon a six.

The odds on the hits.

2 love is about.....	5 to 2
2 to 1 is.....	2 to 1
1 love is.....	3 to 2

If a player has taken up two of the adversary's men, and happens to have two, three, or more points made in his own tables, he should spread his men, that he may either take a new point in his tables, or be ready to hit the man which the adversary may happen to enter. If he finds, upon the adversary's entering, that the game is upon a par, or that the advantage is on his own side, he should take the adversary's man up whenever he can, it being 25 to 11 that he is not hit; except when he is playing for a single hit only, because then, if playing the throw otherwise gives him a better chance for it, he ought to do it.

It being five to one against his being hit with double dice, he should never be deterred from taking up any one man of the adversary's.

If he has taken up one of the adversary's men, and happens to have five points in his own tables, yet is forced to leave a blot out of his tables, he should endeavour to leave it upon doublets in preference to any other chance, because in that case the odds are 35 to 1 that he is not hit; whereas it is only 17 to 1 that he is hit upon any other chance.

When the adversary is very forward, a player should never move a man from his own quatre, trois, or deuce points, thinking to bear that man from the point where he put it, as nothing but high doublets can give him any chance for the hit. Instead of playing an ace or a deuce from any of these points, he should play them from his own six or highest points, so that, throwing two fives or two fours, his six and cinque points being eased, would be a considerable advantage to him; whereas if they had been loaded he would have been obliged to play otherwise.

It is the interest of the adversary to take up the player as soon as he enters. The blot should be left upon the adversary's lowest point; that is to say, upon his deuce point rather than upon his trois point, or upon his trois point rather than his quatre point, or upon his quatre point preferably to his cinque point, for a reason before mentioned. All the men the adversary plays upon his trois or his deuce point are deemed lost, being greatly out of play; so that those men not having it in their power to make his cinque point, and his game being crowded in one place and open in another, the adversary must be greatly annoyed by the player.

If the player has two of the adversary's men in his tables, he has a better chance for a hit than if he had more, provided his game is more forward than that of his antagonist; for if he had three or more of the adver-

sary's men in his tables, he would stand a worse chance to be hit. Backgam-
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When a player is running to save the gammon, if he should have two men upon his ace point and several men abroad, although he should lose a point or two in putting his men into his tables, it is his interest to leave a man upon the adversary's ace point, because it will prevent his adversary from bearing his men to the greatest advantage, and at the same time the player will have a chance of the adversary's making a blot, which he may chance to hit. However, if a player finds upon a throw that he has a probability of saving his gammon, he should never wait for a blot, as the odds are greatly against his hitting it, but at once embrace that opportunity to escape.

Suppose the adversary has so many men abroad as to require three throws to put them into his tables, and at the same time that the player's tables are made up, and that he has taken up one of the adversary's men; in this case it is about an equal wager that the adversary is gammoned; for in all probability the player has borne two men before he opens his tables, and when he bears the third man he will be obliged to open his six or cinque point. It is then probable that the adversary is obliged to throw twice before he enters his men in the player's tables, twice more before he puts that man into his own tables, and three throws more to put the men which are abroad into his own tables; in all seven throws. Now the player having twelve men to bear, he may be forced to make an ace or a deuce twice before he can bear all his men, and consequently will require seven throws in bearing them; so that, upon the whole, it is about equal whether the adversary is gammoned or not.

Suppose a player has three men upon his adversary's ace point and five points in his own tables, and that the adversary has all his men in his tables, three upon each of his five highest points; has the player a probability of gammoning his adversary or not?

	Points.
For bearing three men from his 6th point is.....	18
From his 5th point.....	15
From his 4th point.....	12
From his 3d point.....	9
From his 2d point.....	6

In all 60

Bringing his three men from the adversary's ace point to his six point in his own tables, being 18 points each, and making together.....54

There must remain.....6

From which it is plain that the player has much the best of the probability of the gammon; exclusive of one or more blots which the adversary is liable to make in bearing his men, and supposing at the same time the throws to be upon an equality. But suppose two blots are left, either of which cannot be hit but by double dice; one must be hit by throwing eight, and the other by throwing nine; so that the adversary has only one die to hit either of them. What, then, are the odds of hitting either of them?

The chances of two dice being in all.....	36
The chances to hit 8 or 6 and 2 twice.....	2
5 and 3 twice.....	2
2 Deuces.....	1
2 Fours.....	1
The chances to hit 9 or 6 and 3 twice.....	2
5 and 4 twice.....	2
2 Trois.....	1

For hitting in all.....11

Chances for not hitting remain.....25

So that the odds are 25 to 11 against hitting either of these blots.

Backer
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Bacularius.

This method may be taken to find out the odds of hitting three, four, or five blots upon double dice, or blots made upon double and single dice at the same time. After knowing how many chances there are to hit any of these blots, they must be added all together, and then subtracted from the number 36, which are the chances of the two dice; and the question is solved.

The laws of backgammon are as follow: 1. If a man is taken from any point, it must be played; if two men are taken from it, they also must be played. 2. A man is not supposed to be played till it is placed upon a point and quitted. 3. If a player has only fourteen men in play, there is no penalty inflicted, because by his playing with a lesser number than he is entitled to, he plays to a disadvantage for want of the deficient man to make up his tables. 4. If he bears any number of men before he has entered a man taken up, and which of course he was obliged to enter, such men so borne must be entered again in the adversary's tables as well as the man taken up. 5. If he has mistaken his throw and played it, and his adversary has thrown, it is not in the choice of either of the players to alter it, unless they both agree so to do.

BACKER, or BAKKER, *Jacob*, portrait and historical painter, was born at Harlingen in 1609, but spent the greater part of his life at Amsterdam. He is mentioned as a skilful painter, particularly of portraits, which he executed with boldness, spirit, and grace. He was remarkable for an uncommon readiness of hand and freedom of pencil; while his incredible expedition in his manner of painting appeared even in a half-length portrait of a lady from Haerlem, which was begun and finished in one day, although he adorned the figure with rich drapery and several ornamental jewels. He also painted historical subjects with considerable success; and in that style there is a picture by him of Cimon and Iphigenia, which is accounted an excellent performance. He died in 1651.

BACKERGUNGE, a district in the province of Bengal, a considerable proportion of which, called Boklah, extends along the western bank of the great Ganges, nearly to its mouth, at the island of Rabnabad, which forms the south-east angle of the Bengal Delta. About the year 1584 part of this district was laid waste by an inundation of the ocean, from which it has never yet recovered. The other parts, however, are extremely productive, being fertilized by the inundations of the river, and yielding annually two crops of rice. It is very unhealthy, owing to the damp, and is infested with tigers and alligators of an enormous size; and by the still greater plague of river pirates, who have had their abode there from time immemorial, and plunder, and frequently murder, those who fall into their power, or torture them in order to extort from them a disclosure of their hidden wealth. All the efforts of the British government to suppress this banditti have hitherto failed, although a strong establishment of boats and sepoy is maintained at the town of Backergunge, which is the capital of the district, and the residence of the judge and magistrate. It is 120 miles east of Calcutta. Long. 89. 20. E. Lat. 22. 42. N.

BACKING the SAILS, in *Navigation*, is to arrange them in a situation that will force the ship to move backwards.

BACKSCHISARAI, a city in the European Russian government of Taurida, formerly the capital of the peninsula, and the residence of the khan. It was formerly a place of considerable trade, and in 1793 contained 1560 houses, with 5777 inhabitants. It has, however, greatly declined since the peninsula was transferred to Russia. Long. 38. 39. E. Lat. 44. 39. N.

BACULARIUS, in writers of the middle age, an ecclesiastical apparitor or verger, who carries a staff, *baculus*, in his hand, as an ensign of his office.

Bacon.

BACON, ROGER, a Franciscan friar of great genius and learning, was born near Ilchester in Somersetshire in the year 1214. He began his studies at Oxford, but in what school or college is uncertain. Thence he removed to the university of Paris, which in those times was esteemed the centre of literature. Here, we are told, he made such rapid progress in the sciences, that he was esteemed the glory of that university, and was much caressed by several of his countrymen, particularly by Robert Greathead, afterwards bishop of Lincoln, his friend and patron. About the year 1240 he returned to Oxford, and, assuming the Franciscan order, prosecuted his favourite study of experimental philosophy with unremitting ardour and assiduity. In this pursuit, in experiments, instruments, and scarce books, he tells us he spent, in the space of twenty years, no less than L.2000, which, it seems, was given him by some of the heads of the university to enable him to continue his interesting inquiries. But such extraordinary talents, and astonishing progress in sciences which, in that ignorant age, were totally unknown to the rest of mankind, whilst they raised the admiration of the more intelligent few, failed not to excite the envy and malice of his illiterate fraternity, who found no difficulty in possessing the vulgar with the notion that Bacon dealt with the devil. Under this pretence he was restrained from reading his lectures; his writings were confined to his convent; and, finally, in 1278, he was himself imprisoned in his cell. At this time he was sixty-four years of age. Nevertheless, being permitted the use of his books, he persevered in the rational pursuit of knowledge, corrected his former labours, and wrote several curious pieces. When he had been ten years in confinement, Jerome de Ascoli being elected pope, Bacon solicited his holiness for release, but did not immediately succeed in his object. However, towards the latter end of that pope's reign he obtained his liberty, and spent the remainder of his life in the college of his order, where he died in 1294, in the eightieth year of his age, and was buried in the Franciscan church. Bale and others have enumerated a multitude of pieces as written by Bacon, and existing in manuscript in various collections. Several of his tracts were published in the work entitled *Epistolæ Fratris Rogeri Baconis de Secretis Operibus Artis et Naturæ, et de Nullitate Magiæ*. Paris, 1542, 4to; Basil, 1593, 8vo. His *Opus Majus*, which forms a sort of digest of his preceding writings, remained unpublished till 1733, when it was given to the world in a handsome folio volume by Dr Jebb. Some of his chemical tracts may be found in the *Thesaurus Chemicus*, published in an octavo volume at Frankfort in 1603 and 1620. By an attentive perusal of his works, the reader will find that Roger Bacon was a great linguist and a skilful grammarian; that he was well versed in the theory and practice of perspective; that he understood the use of convex and concave glasses, the *camera obscura*, burning-glasses, &c.; that he was conversant in geography and astronomy; that he knew the great error in the calendar, assigned the cause, and proposed the remedy; that he understood chronology well; that he was in all probability the inventor of gun-powder; that he possessed considerable knowledge in the medical art; and that he was an able mathematician, logician, and theologian.

BACON, *Sir Nicholas*, lord keeper of the great seal in the reign of Queen Elizabeth, was born at Chislehurst in Kent in 1510, and educated at the university of Cambridge, after which he travelled in France, and made some stay at Paris. On his return he settled in Gray's Inn, and applied himself with such assiduity to the study of the law, that he quickly distinguished himself; and, on the dissolution of the monastery of St Edmund's Bury in

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Suffolk, he had a grant from King Henry VIII., in the thirty-sixth year of his reign, of several manors. In the thirty-eighth of the same king he was promoted to the office of attorney in the court of wards, which was a place both of honour and profit. In this office he was continued by King Edward VI.; and in 1552 he was elected treasurer of Gray's Inn. His great moderation and consummate prudence preserved him through the dangerous reign of Queen Mary. In the very dawn of that of Elizabeth he was knighted; and on the 22d of December 1558, the great seal of England having been taken from Nicholas Heath, archbishop of York, was delivered to him, with the title of Lord Keeper; and he was also made one of the queen's privy council. He had a considerable share in the settling of religion; and, as a statesman, he was remarkable for a clear head and wise counsels. But his great parts and high preferment were far from raising him in his own estimation, as appears from the modest answer he gave Queen Elizabeth when she told him his house at Redgrave was too little for him: "Not so, madam," returned he; "but your majesty has made me too great for my house." After having held the great seal more than twenty years, this able statesman and faithful counsellor was suddenly removed from the scene of his labours. He had been under the hands of his barber, and, thinking the weather warm, had ordered a window before him to be thrown open; but he fell asleep as the current of fresh air was blowing in upon him, and awakened some time after distempered all over. He was immediately removed into his bed-chamber, where he died a few days after, on the 26th of February 1578-9, equally lamented by the queen and her subjects. He was buried in St Paul's, where a monument was erected to him, which was destroyed by the great fire of London in 1666. Mr Granger observes that he was the first lord keeper who ranked as lord chancellor; and that he had much of that penetrating genius, solidity, judgment, persuasive eloquence, and comprehensive knowledge of law and equity, which afterwards shone forth with so great splendour in his illustrious son.

BACON, *Francis*, baron of Verulam, viscount of St Alban's, and lord high chancellor of England under King James I. See VERULAM, FRANCIS BACON, baron of. This reference is made in the expectation that we shall be able, by means of it, to give a more correct and comprehensive sketch of Lord Bacon's life than could be drawn from our present materials. His *philosophy* is fully explained in the historical dissertations forming the first volume of this work. See vol. i. p. 32 and 453.

BACON, *John*, academician, born 24th November 1740, who may be considered as the founder of the British school of sculpture, and whose works are still its greatest boast, was the son of Thomas Bacon, cloth-worker in Southwark, whose forefathers possessed a considerable estate in Somersetshire.

At the age of fourteen he was bound apprentice in Mr Crispe's manufactory of porcelain at Lambeth, where he was at first employed in painting the small ornamental pieces of china, but soon attained the distinction of being modeller to the work. The produce of his labour was devoted by him, from his earliest years, towards the support of his parents. While thus engaged, he had an opportunity of seeing the models executed by different sculptors of eminence, which were sent to be burned at an adjoining pottery. An observation of these productions appears to have immediately determined the direction of his genius; and his progress in the imitation of them was no less rapid than his propensity to the pursuit was

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strong. His ardour and unremitting diligence are best proved by the fact, that the highest premiums given by the Society for the Encouragement of Arts in those particular classes in which he was a competitor, were adjudged to him nine times between the years 1763 and 1776. During his apprenticeship he likewise formed the design of working statues in artificial stone, which he afterwards carried to perfection.

Mr Bacon first attempted working in marble about the year 1763, and, during the course of his early efforts in this art, was led, by the resources of his genius, to improve the method of transferring the form of the model to the marble (technically called *getting out the points*), by the invention of a more perfect instrument for this purpose, and which has since been adopted by many sculptors both in this and other countries.¹ The advantages which this instrument possesses above those formerly employed are, its greater certainty and exactness, that it takes a correct measurement in every direction, is contained in so small a compass as not to encumber the workman, and is transferable either to the model or the marble, as may be required, without the necessity of a separate instrument for each.

In the year 1769 the first gold medal given by the Royal Academy was adjudged to Bacon, and in 1770 he was associated by that body. His first work in sculpture was a bust of his majesty George III., intended for Christ Church College. It is said, that of sixteen different competitions in which he engaged with other artists, he was unsuccessful in one case only. His knowledge of the antique style was for a time called in question; and on occasion of the doubts which were raised on this point, he is reported to have modelled his head of Jupiter Tonans, as the most satisfactory method of repelling the charge. The objection probably originated from the circumstance, that in some of his principal works the figures were represented in the costume of modern times, of which his statue of Justice Blackstone at All Souls College, Oxford, and that of Howard in St Paul's Cathedral, are remarkable examples. But his genius was not subjected to the trammels of this or of any one style exclusively. Many of his emblematical figures are designed after the purest models, and in a taste altogether classical. Among several of this character, the monument to Mrs Draper, in the cathedral of Bristol, is exquisitely simple. In his later productions, likewise, particularly those of a monumental kind, he introduced frequent examples of the ancient style; as in the well-known monument to the earl of Chatham in Westminster Abbey, that to Lord Robert Manners, and others which might be mentioned. "Another marble, scarcely finished at the time of his death," says Dallaway, in his *Anecdotes of the Arts in England*, "will secure him a lasting fame for originality and classical taste. It is the cenotaph lately erected in Westminster Abbey to the poet Mason. A muse, holding his profile on a medallion, reclines on an antique altar, on which are sculptured, in relief, a lyre, the tragic masque and laurel wreath; all of the most correct form, as seen on ancient sarcophagi of the pure ages."

On the 4th of August 1799 Mr Bacon was suddenly attacked with an inflammation of the bowels, which occasioned his death in little more than two days. He died in his 59th year, leaving a widow, his second wife, and a family of six sons and three daughters.

Of his merit as a statuary, the universal and established reputation of his works has afforded the decisive proof. "The works of Bacon, Banks, Nollekins, Wilton, and

¹ The invention has sometimes been erroneously ascribed to Monsieur Hudon, a French sculptor.

Bacon-
thorp
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Badajoz.

Flaxman," says Dallaway, and to these might now perhaps be added other names of nearly equal promise, "will rescue the present age from being totally indebted to foreigners for perfection in statuary." The various productions of this artist which adorn St Paul's Cathedral, Christ Church and Pembroke Colleges, Oxford, the Abbey Church at Bath, and Bristol Cathedral, give ample testimony to his powers; above all, those great and prominent works among the monuments in Westminster Abbey.

But it was not as an artist only that Mr Bacon was esteemed; he was no less distinguished by the firmness of his mind, and the uprightness of his private character. His principles were deeply founded, and the virtues which he strove to attain were measured by a standard more unbending than the mere dictates of feeling or of a cultivated taste. He was an avowed believer in the truths of the Christian religion; and in him this belief exhibited its corresponding effects, by producing a consistent influence upon his whole character and conduct. In this manner, the strength of his principles, and the reality of his conviction, were daily manifested throughout his life, than which, no test of sincerity is more unequivocal, no instruction more useful, and no recommendation more persuasive.

Mr Bacon was remarkable for the simplicity of his manners, and was in all things devoid of ostentation. Of the general powers of his mind, and particularly of his acute and just perception in matters of taste connected with his art, a very favourable opinion will be formed by those who peruse the article SCULPTURE which he contributed to Dr Rees's edition of Chambers's *Dictionary*.

See *Memoir of the late John Bacon, R. A.*, by the Reverend Richard Cecil. London, 1811.

BACONTHORP, JOHN, called the Resolute Doctor, a learned monk, was born towards the end of the thirteenth century, at Baconthorp, a village in Norfolk. He spent the early part of his life in the convent of Blackney, near Walsingham, in the same county, whence he removed to Oxford, and thereafter to Paris, where, being distinguished for his learning, he obtained degrees in divinity and laws, and was esteemed the principal of the Averroists. In 1329 he returned to England, and was immediately chosen twelfth provincial of the English Carmelites. In 1333 he was sent for to Rome, where, we are told, he first maintained the pope's sovereign authority in cases of divorce; but this opinion he is understood to have afterwards retracted. He died in London in the year 1346. Leland, Bale, and Pitts, unanimously give him the character of a monk of genius and learning. He wrote, 1. *Commentaria, seu Quæstiones super quatuor libros Sententiarum*; and, 2. *Compendium Legis Christi, et quodlibeta*; both of which passed through several editions.

BACTRIA, or BACTRIANA, an ancient kingdom of Asia, bounded on the west by Margiana, on the north by the river Oxus, on the south by Mount Paropamisus, and on the east by the Asiatic Scythia and the country of the Massagetæ. It was a large, fruitful, and well-peopled country, containing, according to Ammianus Marcellinus, a thousand cities, though of these only a few are particularly mentioned by historians, of which that formerly called Maracanda, now Samarcand, is the most considerable.

BACTROPERATA, an ancient appellation given to philosophers by way of contempt, denoting a man with a staff and a budget.

BACCULE, in *Fortification*, a kind of portcullis or gate, made like a pit-fall with a counterpoise, and supported by two large stakes. It is usually erected before the corpa de guard, not far from the gate of a place.

BADAJÓZ, a city, the capital of the province of Estremadura, in Spain. It is situated on a plain on the left bank of the Guadiana, is strongly fortified, and contains

an arsenal and military academy, a cathedral, five parish churches, twelve religious houses, and five hospitals. The inhabitants are 14,500. In the late war it was twice taken after severe sieges, which injured the prosperity of the city; but it has now recovered from these calamities, and is the seat of a flourishing trade with Portugal. Long. 6. 21. W. Lat. 38. 30. N.

BADAKSHAN, or BUDUCSHAN, a mountainous district, situated to the north of the great Himalaya ridge, which bounds Hindostan on the north. It is about twenty days journey east-south-east of Buckharia, and nearly south of Kokaun. It comprehends the higher valley of the Amoo, which is here called the Jihon or the Jaxartes, together with all the other valleys of its tributary streams, and all the mountains connected with them as far nearly as the sources of that river. The district of Badakshan rises gradually to its level from the lower and northern part of the province of Balkh, which occupies the left bank farther down the river. This country is described as mountainous and well wooded, and the people uncivilized, and even savage in their manners. They live in villages surrounded with gardens, and situated in the little glens and recesses of the hills. The mountainous districts of this province are famed for some of the richest mines of lapis lazuli and of rubies that are known. The former is found in veins, sometimes of considerable thickness, in a gray matrix; and masses of this stone are occasionally procured capable of being wrought into large slabs. They are carried to Buckharia for sale, and thence to Russia. The rubies are found imbedded in a white earth, in large masses of crystal. Some large and coarse crystals are also found, as well as emeralds, according to the information of Fraser. The chief town is Fyzabad, which is said not to be more than 150 miles from Balkh. There is another town of the same name as the province, and of considerable importance. Mr Fraser could gain little authentic information concerning the people of this remote country, their habits, or the nature of their government. They are, however, rigid and intolerant Mahomedans, among whom it would be dangerous for any European to reside. (Fraser's *Journey into Khorassan*. Elphinstone.)

BADALONA, a town of the province of Catalonia, in Spain, on the sea-coast, 10 miles north-east from Barcelona. It is defended by a castle, and remarkable as the landing place of the archduke Charles of Austria in the war of the succession in 1704. It contains about 2800 inhabitants, mostly seamen and fishermen.

BADEN, a grand duchy. See GERMANY.

BADEN, or BADEN-BADEN, a town in the grand duchy of Baden, celebrated for its medicinal springs, which rise from twenty-six wells of the warmth of from 110° to 118° of Fahrenheit. This is a place of great resort for company in the summer, as well on account of the baths as for the picturesque scenery of the vicinity. The city contains about 3000 resident inhabitants; but the numbers visiting it in the appropriate season very far exceed the regular population. There are bathing-houses and promenades, conversation and gaming rooms, libraries, and all the other appendages of a fashionable watering place. It is about four miles from the Rhine, in the Black Forest, near an ancient castle with some curious subterranean apartments.

BADEN, a city in the canton of Aargau, in Switzerland, which gives its name to a circle around it containing 54 townships, with 42 parish churches, 850 houses, and about 5950 inhabitants. The city is on the river Limmat, and near it are several warm springs of great medicinal celebrity, which induces crowds of visitors to repair to them in the appropriate season. It contains about 1650 resident inhabitants, who depend chiefly upon the annual visitors.

Badakshan
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Baden.

Baden
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Bætylia.

BADEN, a small city in the Austrian province of the Lower Ens, in the circle of Wiener Wald. It is about twelve miles from Vienna, and is the most fashionable summer resort of the inhabitants of that capital. The situation is highly romantic, and the prospects in its vicinity are picturesque and beautiful. There are many warm baths, which are visited for the restoration of health by a great number of patients. Accommodations and amusements are here as amply furnished to the visitors as at the other German Spas. It suffered much by a fire in 1812, but has since been very elegantly rebuilt. The archduke Charles has a residence at this place; and the imperial family are frequently to be seen here in a plain domestic style. The resident inhabitants are about 2300, but the occasional visitors commonly exceed that number. It stands on the rapid river Schwachat, whose water-falls add to the beauties of the walks.

BADENOCH, a district of Inverness-shire in Scotland. (See *INVERNESS-SHIRE*.)

BADEN-WEILLER, a town of Germany, belonging to the lower margravate of Baden. Long. 7. 50. E. Lat. 47. 55. N.

BADENS, FRANCIS, historical and portrait painter, born at Antwerp in 1571, died in 1603. His touch was light and spirited, and his colouring warm, in which, indeed, he had the honour of being the first who introduced a good taste among his countrymen.

BADGER. See *MAMMALIA Index*.

BADILE, ANTONIO, historical and portrait painter, born at Verona in 1480, died in 1560. By great study and application he acquired a more extensive knowledge of the true principles of painting than any of his predecessors. He was confessedly a very eminent artist; but he derived greater honour from having had two such disciples as Paolo Veronese and Baptista Zelotti, than from the excellence of his own compositions.

BADIUS, JOSSE, sometimes called **BADIUS ASCENSIVS**, from the village of Asche, where he was born in 1462, an eminent French printer, whose printing establishment was celebrated under the name of *Prelum Ascensianum*. He illustrated with notes several of the works which he printed, and was himself the author of several pieces, particularly a life of Thomas a Kempis, and a satire on the follies of women, entitled *Navicula Stultarum Mulierum*. He died in 1535.

BÆTICA, a province of ancient Spain, so called from the famed river Bætis, afterwards Tartessus, now Guadalquivir or the great river. It was bounded on the west by Lusitania, on the south by the Mediterranean and Sinus Gaditanus, and on the north by the Cantabric Sea, now the Bay of Biscay. On the east and north-east its limits cannot be so well ascertained, since they are thought to have been in a continual state of fluctuation, as each petty monarch had an opportunity of encroaching upon his neighbour.

BÆTYLIA, anointed stones, worshipped by the Phœnicians, by the Greeks before the time of Cecrops, and by other barbarous nations. They were commonly of a black colour, and consecrated to some god, as Saturn, Jupiter, the Sun. Some are of opinion that the true original of these idols is to be derived from the pillar of stone which Jacob erected at Bethel, and which was afterwards worshipped by the Jews. These *bætylia* were the objects of much veneration among the ancient heathens. Many of their idols were in fact no other; and no sort was more common in eastern countries than that of erect oblong stones, hence termed by the Greeks *κίονες*, pillars. In some parts of Egypt they were planted on both sides of the highways. In the temple of Heliogabalus in Syria, there was one said to have fallen from hea-

Bæza
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Bagdad.

ven; and in Phrygia there was a black stone, also considered an aerolithe, which the Romans sent for, and received with much ceremony, Scipio Nasica having been at the head of the embassy.

BÆZA, a city of Andalusia in Spain, seated on a high hill three miles from the Guadalquivir. It is the see of a bishop, and has a kind of university founded by John d'Avila. It was taken from the Moors about the end of the fifteenth century. Long. 3. 15. E. Lat. 37. 45. N.

BAFFIN'S BAY, a gulf of North America, separating Greenland from the north-eastern part of America. Davis' Straits form the lower part or entrance of this bay or gulf.

BAFFO, a town in the island of Cyprus, with a fort built near the site of the ancient Paphos, of which some ruins yet remain, particularly fragments of columns, which probably belonged to the temple of Venus. Long. 32. 20. E. Lat. 34. 50. N.

BAGDAD, a city of Asia, formerly the capital of the empire of the caliph, and long renowned for its commerce and its wealth. It is situated on an extensive and desert plain, with scarcely a tree or village throughout its whole extent; and, though it is intersected by the Tigris, it stands mostly on its north-east bank, close to the water's edge. Old Bagdad on the west is now considered only as a suburb to the larger and more modern city on the eastern shore. It has, however, numerous and extensive streets, well furnished with shops, and is protected by strong walls, and three gates opening towards Hillah on the Euphrates and Kazameen. Beyond these recent bulwarks, vestiges of ancient buildings, spreading in various directions, are visible in the plain, which is strewn with fragments of brick, tiles, and rubbish. A burying-ground has extended itself over a large tract of land formerly occupied by the streets of the city; and here is the tomb of Zobeida, the favourite wife of Haroun el Raschid, built of brick, of a high octagonal shape, and surmounted by a lofty superstructure in the form of a cone. The two towns of Old and New Bagdad are connected by a ruinous bridge of thirty pontoons, so decayed that few of the natives venture across it. The form of the new city is that of an irregular oblong, about 1500 paces in length by 800 in breadth; and a brick wall, 1500 paces in length and about five miles in circuit, incloses the town on both sides of the river. This wall, which is built of brick, has been constructed and repaired at different periods; and, as in most other works of the same nature in Mahomedan countries, the oldest portion is the best, and the more modern the worst part of the fabric. At the principal angles are large round towers, with smaller towers intervening at short distances; and on these large towers batteries are planted, with about fifty brass cannon of different calibre, badly mounted. On two of these angular towers, Mr Buckingham remarked that the workmanship is equal to any ancient masonry that he had ever seen. The wall has three gates, one on the south-east, one on the north-east, and a third on the north-west of the city; and it is surrounded by a dry ditch of considerable depth. The town has been built without the slightest regard to regularity. The streets are even more intricate and winding than those in many other eastern towns; and, with the exception of the bazars and some open squares, the interior is little else than a labyrinth of alleys and passages. The streets are unpaved, and in many places so narrow that two horsemen can scarcely pass each other; and as it is seldom that the houses have windows facing the great public thoroughfares, and the doors are small and mean, they present on both sides the gloomy appearance of dead walls. All the buildings, both public and private, are constructed of furnace-burnt bricks, of a yellowish red colour, taken chiefly from the ruins of other

Bagdad. edifices, as their rounded angles evidently show. A house is generally laid out in ranges of apartments opening into a square interior court, and furnished with subterranean rooms called *serdaubs*, into which the inhabitants retreat during the day for shelter from the intense heats of summer; and with terraced roofs, on which they take their evening meal, and sleep in the open air. In the months of June, July, and August, the thermometer at break of day generally stands at 112° of Fahrenheit; at noon it rises to 119°, and a little before two o'clock to 122°; at sunset it is about 117°, and at midnight 114°. In some seasons it rises even higher; and at these times the inhabitants during the day take refuge in the subterranean apartments, where they contrive, by every possible device, to mitigate the intolerable heat. In the interior the houses of the rich are splendidly furnished, and ornamented in the ceilings with a sort of chequered work, which has a grand appearance. A great portion of the ground within the walls of the town is unoccupied by buildings, especially in the north-eastern quarter; and even in the more populous parts of the city, near the river, there is a considerable space between the houses, occupied by gardens, in which are produced pomegranates, grapes, figs, olives, and dates, in great abundance, so that the city, when seen from a distance, has the appearance of rising out of the midst of trees.

The public buildings in Bagdad are chiefly the mosques, the khans or caravanserais, and the serai or palace of the pasha. This latter building, which is situated in the north-western quarter of the town, not far from the Tigris, is rather distinguished for extent than grandeur; it is a comparatively modern structure, and being built at different periods, it forms a large and confused pile, without either architecture, beauty, or strength. There are no remains of the ancient palace of the caliphs.

In all Mahomedan cities the mosques are conspicuous objects. The number in Bagdad is above 100; but of these not more than thirty are distinguished by their particular minarets or steeples, the rest being merely chapels and venerated places of prayer. The most ancient of these mosques was erected in the year of the Hegira 633, or 1235 of the Christian era, by the Caliph Mostanser. All that remains of the original building is the minaret, and a small portion of the outer walls; the former a short, thick, heavy column of the most ungraceful proportions, built of bricks, diagonally crossed, and of various colours. The jamah or mosque of Merjameeah, not far distant from the former, though the body of it is modern, has some remains of old and very rich arabesque work on its surface. The door is formed by a lofty arch of the pointed form, bordered on both sides by rich bands exquisitely sculptured, and having numerous inscriptions. The mosque of Khassakey is chiefly distinguished by the niche for prayer, which, instead of a simple and unadorned recess, is crowned by a Roman arch, with square pedestals, spirally-fluted shafts, a rich capital of flowers, and a fine fan or shell-top in the Roman and not in the Arabic taste. Around the arch is a sculptured frieze; and down the centre, at the back of the niche, is a broad band, richly sculptured with vases, flowers, &c. in the very best style of workmanship; the whole executed on a white and fine ground marble. The mosque of the vizier, near the Tigris, has a fine dome and lofty minaret; and the great mosque in the square of El Maidan is also a noble building. The others do not merit any particular notice. The domes at Bagdad are mostly high, and disproportionately narrow. They are richly ornamented with glazed tiles and painting, the colours

chiefly green and white, which being reflected from a polished surface, give rather a liveliness than a magnificence to the aspect of these buildings. But, in the opinion of Mr Buckingham, they are not to be compared to the rich and stately domes of Egypt, as the minarets, although they have the same bright assemblage of colours, are far from being equal "to the plain and grave dignity of some of the Turkish towers at Diarbekir, Aleppo, and Damascus, or to the lighter elegance of many of those in the larger towns on the banks of the Nile."¹

There are about thirty khans or caravanserais in Bagdad, all of inferior construction to those in the other large towns of Turkey. The bazars, which are numerous, are mostly formed of long, straight, and tolerably wide avenues. The one most recently built is the longest and the best, though it has still an air of meanness about it not common in the bazars of large Turkish cities. It is long, wide, and lofty, and well filled with dealers and wares of all sorts. Several of these bazars are vaulted over with brick work; but the greater number are merely covered with flat beams laid across, to support a roof of straw, dried leaves, or branches of trees and grass. There are about fifty baths in Bagdad, which are also far inferior in their accommodations to those in the other large towns of Mesopotamia.

Bagdad is about 500 miles from the mouth of the Tigris, including its windings, and about 400 from Bussora; and with this latter place it carries on a constant communication by means of boats, from twenty to fifty tons burden, though the river is navigable for larger vessels. With a northerly wind these boats will make the passage to Bussora in seven or eight days; in calms, when they have merely the aid of the current, the passage occupies from ten to fifteen days. Sir R. K. Porter mentions that the stream of the Tigris runs at the rate of seven knots an hour. This, however, is probably during floods, since, with such a powerful current, a boat could not occupy ten or fifteen days on its passage from Bagdad to Bussora. In coming up the stream, thirty or forty days are consumed before reaching Bagdad. The smaller craft, used for bringing supplies of provisions and fruit to the city, are circular boats of basket-work, covered with skins, the same that have been employed from the remotest antiquity. The communication with Bussora used formerly to be carried on by the way of Hillah on the Euphrates; but the banks of this river are now in possession of a tribe of Arabs, who detain and plunder all vessels sailing down the river, and frequently murder the crews. The Euphrates and the Tigris are liable to spring floods; and the streams of both rivers being joined, inundate the desert plain on which Bagdad stands, when the city appears like an island in the midst of the sea. The inhabitants are supplied with water from the Tigris, which is brought to their houses in goats' skins; the convenience of water-works, cisterns, and pipes, being entirely unknown.

Bagdad has declined from its ancient importance. It was formerly a great emporium of eastern commerce; and it still receives, by way of Bussora, from Bengal, the manufactures and produce of India, which are distributed over Arabia, Syria, Koordistan, Armenia, and Asia Minor. This trade has increased, owing to the moderate demands of the government, from two annual vessels to six under the English flag, besides those under Arabian colours. At the same time the inland trade from Persia and the East has declined. The productions and manufactures of Persia which were intended for the Syrian, Armenian, and Turkish markets, and were sent to Bagdad as a central depôt, now reach Constantinople by the more direct route

¹ Buckingham's *Travels in Mesopotamia*, vol. ii. chap. vii.

Bagdad. of Erzerum and Tocat. Wealth appears to be deficient among all classes, and Bagdad has many symptoms of a decayed city.

The population is a mixture of nations from various quarters of the East. The chief officers of government, whether civil or military, are of the families of Constantinopolitan Turks, though they are mostly natives of the city; the merchants and traders are almost all of Arabian descent; while the lower classes consist of Turks, Arabs, Persians, and Indians. There are some Jews and Christians, who still remain distinct from the other classes; while the strangers in the town are Koords, Persians, and Desert Arabs in considerable numbers. The dress of the Bagdad Turks is not nearly so gay or splendid as that of their northern countrymen; and the costume of the Bagdad residents is, upon the whole, unusually plain in comparison with that of other Asiatics. As every nation retains its own peculiar dress, it may be easily conceived what an amusing variety of costume must be seen in the streets of Bagdad. The dress of the females is as mean as that used in the poorest villages of Mesopotamia; women of all classes being enveloped in a blue checked cloth, such as is worn by the lowest orders in Egypt, and having their faces covered by hideous veils of black horse-hair.

Bagdad is governed by a pasha, assisted by a council. The pasha receives his appointment from the sultan of Constantinople; which, however, has to be ratified by the public voice, not ascertained by votes, but expressed in the tumultuous acclamations of the populace. The pasha is chosen from a body of Georgian Mamelukes, maintained by importations from Georgia, which are said to increase every year. Among this body are distributed all the lucrative offices, as well as all the military commands. The pasha has a force of 2000 horsemen, 10 pieces of artillery, and a body-guard consisting of 1000 men. On particular emergencies he can call for the service of some Arab tribes of the Desert, who are bound to this duty in return for provisions supplied by the pasha; the pashas of Koordistan also aid him with 5000 or 6000 horse in case of need; so that on a short notice he can collect a force of 20,000 or 30,000 undisciplined troops for the defence of the city. He is generally considered as quite independent of the sultan of Constantinople. His revenue arises from a custom-duty on all merchandise entering Bagdad; and he seldom resorts to forced exactions for the supply of his treasury. The moderation and justice pursued by the government has the effect of giving great activity to commerce, and general satisfaction to all engaged in it. The police of Bagdad is extremely defective, and murders frequently take place at the gates of the palace and of the great mosque, without any attempt being made to bring the criminals to justice. Mr Buckingham mentions, that one murder was committed in open day, on the street, before a hundred witnesses, no one of whom thought of interfering; it being, according to the maxims of the Arabs, an affair of blood, which it belonged to the relatives of the slain to revenge, or the pasha to investigate, and which they had no business to meddle with. Robberies are also frequently committed with impunity. The English and French maintain each a consul at Bagdad. The late Mr Rich, whose amiable qualities furnish a theme of praise to every traveller, was appointed to that situation by the East India company, with a large establishment, and was considered the most powerful man in Bagdad next to the pasha.

Bagdad was founded by Al Mansour, second caliph of the race of Abbas, in the 145th year of the Hegira (A. D. 747). It was adorned with many noble and stately edifices by the magnificence of the renowned Haroun el Racshid, who also built on the eastern side of the river, connecting the two quarters of the town by a bridge of

boats. Under the auspices of Zobeida, the wife of that prince, and Jaffer Barmecide, his favourite, the city may be said to have attained its greatest splendour. It continued to flourish and increase, and to be the seat of elegance and learning, until the 656th year of the Hegira (A. D. 1257), when Holakoo the Tartar, the grandson of Genghis Khan, took it by storm, and extinguished for ever the reign of the Abbassides. The Tartars retained possession of Bagdad till about the year 1400 of our era, when it was taken by Tamerlane, from whom the sultan Ahmed Ben Avis fled, and finding refuge with the Greek emperor, contrived afterwards to repossess himself of the city, whence he was finally expelled by Kara Yusef in 1417. In 1477 his descendants were driven out by Usun Cassim, who reigned 39 years in Bagdad, when Shah Ismael the First, the founder of the royal house of Sefé, made himself master of it. From that time it continued for a long period an object of contention between the Turks and Persians. It was taken by Soliman the Magnificent, and retaken by Shah Abbas the Great; and it was afterwards besieged by Amurath the Fourth, with an army of 300,000 men. After an obstinate resistance, it was forced to surrender, A. D. 1638, when, contrary to the terms of the capitulation, most of the inhabitants were massacred by torch-light. Since this period it has remained under a nominal subjection to the Turks. Ashmed, the greatest of the pashas of Bagdad, and the first who rendered the pashalic independent of the porte, defended the town with such courage and success against Nadir Shah, that he was compelled to raise the siege, after suffering great loss. The population of Bagdad is variously estimated at from 50,000 to 100,000. Mr Buckingham's estimate is 80,000, which is probably not far from the truth. Long. 44. 24. E. Lat. 33. 21. N. (Buckingham's *Travels in Mesopotamia*; Sir R. Ker Porter's *Travels in Georgia, Persia, Armenia, and Ancient Babylonia*; Kinneir's *Geographical Memoir of the Persian Empire*.)

BAGDAD, or, as it is sometimes called, ARABIAN IRAK, is also a Turkish pashalic or government of Asia, and is computed to extend 840 miles in length by 636 in breadth. It stretches, in a north-west direction, from the mouth of the Shat-ul-Arab at Bussora, to Merdin, situated near the source of the Tigris; and from the confines of Persia west to the banks of the Khabaur, which separates it from the pashalic of Orfa. Its general boundaries are the Euphrates and the Arabian desert of Nedjed to the west and south, Kusistan and Mount Zagros to the east, the pashalic of Diarbekir to the north-west, and Armenia with the territories of the Kurdish chief of Julamerick to the north. This great tract comprehends ancient Babylonia, and the greatest part of Assyria Proper. The first includes the space inclosed by the Tigris and the Euphrates, which is also known under the general appellation of Mesopotamia; and the second, that which is beyond the Tigris, commonly called the Lower Koordistan. This tract of country is an extensive plain, extremely fertile, and is watered by the Tigris and the Euphrates, which at Bagdad approach within 25 miles of each other, and afford an inexhaustible supply of the finest water. Only some parts of those fertile districts, however, are cultivated, as the population consists in many places of wandering Arabs, who are averse to agriculture, and who, in their vagrant life of idleness and rapine, neglect all the natural advantages of a fertile country. The most productive portion of the pashalic is on the banks of the Shat-ul-Arab, in the neighbourhood of Bussora. This tract, for upwards of 30 miles below that city, is well cultivated, and yields vast quantities of dates, wheat, barley, and various kinds of fruits. The banks of the Euphrates produce abundant crops of dry grain. Higher up the Euphrates, the country which

Bagdad is possessed by the Arabs is a low marshy tract, formed by the expansion of the Euphrates, and is famed for plentiful crops of rice. Among the mountainous districts of the Upper Euphrates the country is highly picturesque and beautiful; it is watered by the river Mygdonius, and is in a tolerable state of cultivation. The finest fruits, such as grapes, olives, figs, pomegranates, which are esteemed the most delicious in the East; apples, pears, apricots of an inferior quality; and the finest dates, on which the inhabitants, as in other parts of Asia, depend in many cases for subsistence; are produced in abundance. The domestic animals are, the horse, for which the country has long been famed, the ass, camels, dromedaries, buffaloes, and mules. Of the wild animals, the jackal is the most destructive. The lion, the hyena, the wolf, and the wild boar, are also common; and antelopes are seen in great numbers. Hares are plentiful, but foxes are seldom seen. All sorts of poultry are bred excepting the turkey. On the cultivated lands, and on the borders of the rivers, the black partridge is met with in great numbers. Snipes and almost every species of wild fowl may be found in the marshes, and pelicans on the banks of the Euphrates and Tigris. In addition to these two rivers, the country is watered by the Khabaur or Chaboras, formed of a variety of little brooks about ten miles to the southwest of Merdin; by the Mygdonius, which joins the Khabaur; and also by the Hermes, a tributary of the Mygdonius.

In ancient times the plain of Mesopotamia was occupied by the great and wealthy cities of Nineveh, Babylon, Seleucia, Ctesiphon, &c. and was in a high state of cultivation. It was intersected by many well-constructed canals and other works, which, in dispersing over the country the superfluous waters of the Tigris and of the Euphrates, proved extremely useful to agriculture. These works are now all ruined, and not a vestige remains of many of the canals, while the course of others can only be faintly traced in their imperfect remains. One canal is still to be seen, which connects the Euphrates and the Tigris exactly half-way between Bussora and Bagdad, and is navigable in spring for large boats.

The pashalic of Bagdad is occupied by Arabian tribes, some of them very powerful. The sheik of Montefidge, whose tribe inhabits the banks of the Euphrates from Korna to Samavat, can bring into the field 4000 horse and a proportionate number of foot. The Beni Lam, who possess the western bank of the Tigris between Korna and Koote, can muster 1500 horse and 2000 foot. The Beni Hashem, between Samavat and Khuzil, are a small tribe. The Khuzil are more numerous, and possess the country near the marshes of Lemloon. The Gerbai is a powerful and licentious tribe, who have lately come from Nedjed, the central district of Arabia, and they are continually roving about from Kerkesia to Bagdad. There are about thirteen other smaller tribes, who wander about the province, plundering travellers, and rendering insecure the navigation of the Tigris and the Euphrates.

BAGLANA, a large and mountainous district of Hindostan, in the Mahratta territories, province of Aurungabad, through which many fertile plains and valleys are interspersed. It is situated between the 20th and 21st degrees of N. lat.; and the natural strength of the country is augmented by a number of strong fortresses erected on the summits of lofty mountains. This province was first conquered by the Mahometans in 1296, but they were unable to retain their conquest; and from its natural advantages, and the martial disposition of its natives, it appears never to have been entirely subdued, either by the sovereigns of the Deccan or the Moguls. Aurungzebe with his powerful armies made inroads into this country;

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but he never obtained more than its nominal subjection, and an irregularly paid tribute. It revolted from the Delhi emperors on the first appearance of the Mahratta chief Sevajee; and it was wholly held by different Mahratta chiefs till 1818. It was partitioned among a variety of leaders, the limits of whose territories frequently fluctuated. It has no towns of any note.

BAGLIVI, GEORGE, a celebrated physician of Italy, was a native of Apulia, and born about the year 1668. He studied at Padua, where he became doctor; and then went to Rome, where he was chosen professor of anatomy. He died at Rome in 1706, at the early age of thirty-eight. A collection of his pieces, which are all in the Latin language, was published in 4to in 1704, and has been several times reprinted in the same form. An edition in 2 vols. 8vo was published in 1788.

BAGMUTTY, a river of Hindostan, which has its source in the hills to the north of Catmandoo, the capital of Nepal, whence it flows in a southerly direction, and joins the Ganges after a course of 300 miles.

BAGNARA, a city of the province of Calabria Ulteriore, in the kingdom of Naples, on the Tyrrhenian Sea. It suffered by the earthquake in 1783, when, out of 4938 persons, 3324 perished. The injury has been in a great measure repaired, and it now contains a population of 4000 individuals, who carry on a considerable trade in silk, oil, and wine, and in the fishery.

BAGNAREA, a town of Italy, in St Peter's patrimony, and in the territory of Orvieta, with a bishop's see. Long. 12. 10. E. Lat. 42. 36. N.

BAGNERES, an arrondissement of the department of the Upper Pyrenees, in France, 770 square miles in extent, comprehending ten cantons and 202 communes, with a population of 73,630 persons. The capital is the city of Bagnères de Biggore, celebrated for its medicinal springs. It is at the entrance of the beautiful valleys of Medouse and Campan on the Adour, and is much frequented both for health and pleasure. The population is about 6500. Long. 0. Lat. 43. 3. N.

BAGNIALACK, a large town of Turkey in Europe, in the province of Bosnia. Long. 18. 10. E. Lat. 44. 0. N.

BAGNOLAS, a town of Lower Languedoc, now the department of Gard, in France. It has a handsome square, and two fountains which rise in the middle of the town, the waters of which being received in a basin, are conveyed by a canal out of town, and thence to the lands about it. Long. 4. 43. E. Lat. 44. 10. N.

BAGNOLI, a city in the province of Principato-Ulteriore, in the kingdom of Naples, where several Roman antiquities are found, containing 4850 inhabitants.

BAGNOLIANS, or **BAGNOLANSES**, in *Ecclesiastical History*, a sect of heretics, who in reality were Manicheans, though they somewhat disguised their errors. They rejected the Old Testament and part of the New, held the world to be eternal, and affirmed that God did not create the soul when he infused it into the body.

BAGNOLO, a city in the kingdom of Sardinia, in the continental province of Saluzzo. It stands on the river Grana, and contains 4374 inhabitants.

BAGPIPE, a musical instrument, of the wind kind, chiefly used in Scotland and Ireland, but not uncommon in some of the mountainous districts of Italy, particularly in Calabria. The peculiarity of the bagpipe, from which indeed it takes its name, is, that the air which blows it is collected in a leathern bag, whence it is propelled by the arm into the pipes. These pipes consist of a bass and tenor or rather treble, and they are different according to the species of the pipe. The bass part is called the *drone*, and the tenor or treble part the *chanter*. In all the species the bass never varies from its uniform note, and

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Baglivi
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Bagpipe.

Bagpipe. therefore very deservedly gets the name of *drone*; the compass of the chanter is likewise very limited. There is a considerable difference between the Highland and Lowland bagpipe of Scotland; the former being blown with the mouth, and the latter with a small bellows; though this difference is not essential, every species of bagpipe being capable, by a proper construction of the reeds, of producing music either with the mouth or bellows. The following are the species of bagpipe most commonly known in this country.

The *Irish Pipe* is the softest, and in some respects the most melodious of any. The chanter, like that of all the rest, has eight holes or ventiges, like the English flute, and is played on by opening and shutting these as occasion requires; the bass consists of two short drones and a long one. The lowest note of the chanter is D on the German flute, being the open note on the counter-string of a violin; the small drone, one of them being commonly stopped up, is tuned in unison with the note above this, and the large one to an octave below; so that a great length is required in order to produce such a low note, on which account the drone has sometimes two or three turns. The instrument is tuned by lengthening or shortening the drone till it sounds the note desired.

The *Highland Bagpipe* consists of a chanter and two short drones, which sound in unison the lowest note of the chanter except one. This is exceedingly loud, and almost deafening if played in a room; and is therefore mostly used in the field for marches, and at a distance. It requires a prodigious blast to sound it, so that those unaccustomed to it cannot imagine how Highland pipers can continue to play for hours together, as they are frequently known to do. For the same reason, those who use the instrument are obliged either to stand on their feet or walk when they play. This instrument has but nine notes; its scale, however, has not yet been reduced to a very regular standard in comparison with that of other instruments, so that little can be said as to its compass. Those who are acquainted with it, however, affirm that it plays only the natural notes, without being capable of variation by flats or sharps. Pipe-music is now written out according to a peculiar notation.

The *Scottish Lowland Pipe* is likewise a very loud instrument, though less so than the former. It is blown with bellows, and has a bass like the Irish pipe. This species is different from all the rest, as it cannot play the natural notes, but has F and C sharp. The lowest note of a good bagpipe of this kind is unison with C sharp on the tenor of a violin tuned to concert pitch; and, as it has but nine notes, the highest is D in alt. From this peculiar construction, the Highland and Lowland bagpipes play two species of music essentially different, as each of them also is from every other species of music in the world. Hence these two species of bagpipes deserve notice as curiosities; for the music which they play is accompanied with such peculiar ornaments, or what are intended as such, that neither violin, nor even organ, can imitate it, except in a very imperfect manner. This kind of bagpipe was formerly very much used in Scotland at weddings and other festivals; being indeed extremely well calculated for playing that peculiar species of Scottish music called reels. It has often been matter of surprise how this was possible, as the instrument has only a compass of nine or ten notes at the utmost, and which cannot be varied, as in other instruments; but within this range it will play an inconceivable variety of tunes. As its notes are naturally high, there is scarce any one tune that is not transposed by it, so that what would be a flat note on the key proper for the violin may be a sharp one on the bagpipe; and although the latter cannot play any flat note, it may never-

theless in this manner play tunes which on other instruments would be flat, to as great perfection as these instruments themselves. Bahamas.

The *Small Pipe* is remarkable for its diminutive size, the chanter not exceeding eight inches in length; for which reason the ventiges are so near each other, that it is with difficulty they can be closed. This pipe has only eight notes, the lower end of the chanter being commonly stopped to prevent the slurring of all the notes, which is unavoidable in the other species; so that in the hands of bad players they become the most shocking and unintelligible instruments imaginable. But, by having the lower ventige closed, and also by the peculiar way in which the notes are expressed, this pipe plays all its tunes in the manner called by the Italians *staccato*, and cannot slur at all. It has no species of music peculiar to itself, and can play nothing which cannot be much better executed upon other instruments; although it is surprising what volubility skilful performers on this instrument display, and how far they are able to overcome its natural disadvantages. Some of this species, instead of having drones like the others, have their bass parts consisting of a winding cavity in a kind of short case, and are tuned by opening these to a certain degree by means of sliding covers, from which contrivance they are called *shuttle-pipes*. Besides these there are a variety of others called *Italian*, *German*, *Organ*, &c. bagpipes, which have nothing different in their construction from those above described, nor any good quality to recommend them.

BAHAMAS, or LUCAYAS, a chain of islands of great extent, stretching from off the northern coast of St Domingo, to that of East Florida, and situated between the 21st and 28th degrees of north latitude, and the 71st and 81st of west longitude. They have never been regularly surveyed, nor their numbers ascertained with any degree of certainty; but they are estimated at above 500. Of these the principal are, Acklin's Island, Andros Island, Atwood's Key, Great Bahama, Berry Island, Biminis, Caicos, Castle Island, Crooked Island, Eleuthera, Exumas, French Keys, Hog Island, Hog Key, Harbour Island, Heneagus, Little Island, Long Island, Long Key, Mayaguana, New Providence, Ragged Island, Rose Island, Royal Island, Rum Key, Russell Island, St Salvador, Turk's Islands, Watling's Island.

St Salvador, one of the islands composing this chain, was the first land discovered by Columbus on his memorable voyage. At that period the Bahamas were inhabited by a mild and peaceable race of Indians, who, seduced by the arts of the Spaniards, were afterwards consigned to perpetual bondage in the mines of St Domingo, or sent to act as divers in the pearl fisheries of Cumana. From this period the islands continued devoid of inhabitants until 1629, when New Providence was settled by the English, and held till 1641, at which time the Spaniards expelled them, but made no attempts to settle there themselves. It was again colonized by England in 1666, and again ravaged by the French and Spaniards in 1703; after which it became a rendezvous for pirates till 1718, when these were extirpated, a regular colonial administration established, and the seat of government fixed in this island. In 1781 the Bahamas were surrendered to the Spaniards; but at the conclusion of the war they were once more annexed to the British empire, to which they have ever since belonged. At the close of the American war many of the British royalists sought refuge in these islands, and colonized the principal of them, from which period we may date their gradual though slow cultivation and improvement.

Many of the Bahamas are situated on the Great Bahama Bank, others upon the Little Bahama Bank, and some

Bahamas
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Bahar.

out of soundings in the Atlantic Ocean. The greater part of them consist merely of bleak and barren rocks, others are entirely covered with wood; and in general they are very flat, presenting the appearance of sand-banks. In the islands which have been cultivated, the soil is thin, and generally light or sandy, but interspersed with partial spots of rich mould. Though destitute of running streams, they have a number of springs; and by digging wells in the rocks down to the level of the sea, fresh water is obtained. The productions of the soil comprehend all the varieties of a tropical climate. Provisions, such as Guinea and Indian corn, yams, sweet potatoes, plantains, cassava, &c., and fruits, such as oranges, lemons, limes, pine apples, cocoa nuts, &c. are produced in abundance; and so also are different species of timber and dye-woods, such as mahogany, fustic, lignum vitæ, pines, cedars, and the like. There are no sugar plantations, but a little cotton and coffee is raised. Oxen, sheep, horses, poultry, and a great variety of live stock, are reared. The shores and creeks of all the Bahamas abound in turtle and excellent fish of different sorts. There are many varieties of birds; and wild hogs, guanas, &c. are found in the woods. The climate is in general dry and salubrious, and the hurricanes are not violent.

New Providence is about twenty-five miles long by nine miles broad, and is situated between long. 77. 10. and 77. 38. W. and lat. 25. 3. and 25. 20. N. It differs little in soil and productions from the rest of the Bahamas, except that it is considerably in advance in point of cultivation. Nassau, the capital town, the centre of trade, and the seat of government, is situated on the north coast of the island. The houses are built of a stone found in the island, and are remarkably good; the public buildings in particular, such as the government-house, custom-house, courts of justice, &c. are very handsome. New barracks have been lately erected in a situation not very beautiful it is true, but much more healthful than the former. There are several churches, public schools, and charitable institutions in this town, which are well supported. The three other regular ports of entry are the Turk's Islands, Great Exuma, and the Caicos; but their trade is very trifling, and they are still far behind New Providence in cultivation and improvement.

The Bahamas are of more importance to Britain by commanding the Gulf of Florida than from their trade and commerce. The exports consist chiefly of cotton, dye-woods, mahogany, turtle, fruits, and coffee. The salt trade, which was at one time considerable, is now in a great measure abandoned; and the imports consist principally of articles of clothing, provisions, and prepared wood. A great proportion of the inhabitants gain a livelihood by picking up the fragments of wrecks, so frequent in this labyrinth of shoals and rocks, sometimes to the number of 200 vessels annually, and also in giving assistance to those who are in danger, in which precarious trade a vast number of vessels are employed. The population of the Bahamas, according to the returns made to parliament in 1829, consists of—whites, exclusive of white troops, 4152; free blacks and coloured, exclusive of black troops, 2791; slaves, 9297.

BAHAR, a large province of Hindostan, which lies principally between the 22d and 27th degrees of north latitude. On the north it was, until the conquests from Nepaul in 1815, bounded by a range of hills and a low woody country; on the south by the ancient Hindoo province of Gundwana; and on the west by Allahabad, Oude, and Gundwana. It comprehends an area of 51,973 square miles, of which one half, consisting of 26,000 square miles, is an arable plain, fertile, populous, and highly cultivated. This plain is divided into two nearly equal portions by the Ganges, which runs across the province in an

easterly course for 200 miles. The northern division extends 70 miles from the Ganges, to the forests of Nepaul and Morung, on the upper streams of that great river. It is one uninterrupted flat, which was subdivided by the emperor Akbar into four districts, namely, Tirhoot, Hajypoor, Sarun, with Chumparun or Bettiah, including four pergunnahs from Monghir. The central division of Bahar extends south of the Ganges sixty miles, to the commencement of the hilly country, which stretches southward; and it contains 18,000 square miles, not nearly so productive as the plains. This central division contains the district of Bahar, which is in the middle of it, and occupies about one half of the whole level area; the plains of Monghir, one sixth more; and the rest are mountainous. Rhotas, the south-western district, lies between the rivers Soane and Caramnassa; the remaining district Shahabad extends along the south side of the Ganges. There is, besides, a straggling hilly country of 8000 square miles, which is not productive. This province has great natural advantages, and it is favourably situated, between Bengal and the upper provinces, for being the medium of internal commerce. Its climate is temperate, and the soil is fertile, well watered, and productive of the higher grains, as also of opium and other luxuries, which are in request in northern countries. Agriculture, as well as commerce and manufactures, have always flourished in Bahar. Opium may be considered the staple commodity of the country; but, according to the narrow maxims of the East India Company, all that is produced in Bahar and Benares is monopolized by the government, and disposed of in Calcutta by public sale. In addition to those articles, the country yields the ordinary productions of grain, sugar, indigo, oil, betel leaf, and a variety of flower essences, especially roses. Saltpetre is principally manufactured in the divisions of Hajypoor and Sarun, and it scarcely passes the eastern limits of Bahar. Cotton cloths for exportation are manufactured everywhere. The climate is extremely hot; and in Bahar Proper and the contiguous districts, the country is visited by a parching wind from the westward, which prevails through a large portion of the hot season, blowing with great strength during the day, and commonly succeeded at night by a cool breeze in an opposite direction. Sometimes it ceases for days and weeks, giving way to easterly gales. Farther westward, and in the interior of the country, the climate is still hotter, owing to the parching winds which prevail; and it is not so much tempered by refreshing breezes or cooling showers of rain and hail. The Bahar province during the cold season is sometimes liable to a blighting frost. The country is well watered. Its principal rivers are the Ganges, the Soane, the Gunduck, the Dummoodah, the Caramnassa, and the Dewah, besides numerous smaller streams, which supply the country with moisture, and aid its cultivation. The chief towns are Patna, Chuprah, Daoudnagur, Goya, Boglipoor, Monghir, Arrah, Chittra, and Muzufferpoor.

Ever since the British acquired possession of this province in 1764, which is about sixty-six years, it has enjoyed the most profound tranquillity. Hence its cultivation has been continually increasing, and in many parts it is overflowing with people, owing to the predilection of the natives for the settled districts rather than the contiguous wastes. The land in Bahar is divided into smaller zemindaries than in Bengal, and a greater portion of it is in jaghires. The lands have always been let to farm; and from the time that the British acquired the right of collecting the land revenue, no settlement had been concluded with the proprietors of the soil until the final assessment in 1792. The tenantry, though they are left at the mercy of the zemindars or landlords by the revenue settlement, are on the whole in a prosperous condition.

Bahar.

Bahir
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Baiaë.

Experience has taught the zemindars the necessity of treating them justly; and, accordingly, one half of the produce is the usual allowance of the cultivators, and there is such a demand for their industry, that in some cases they are enabled even to make better terms. The hire of a ploughman, since the year of the perpetual settlement in 1792, has nearly doubled, while the price of grain has fallen. This territory was at an early period subdued by the Mahomedan invaders. The large towns on the Ganges have always been their favourite residences, and hence a considerable proportion of the population. About one fourth profess the Mahomedan faith. The amount of the land tax is 6,152,435 rupees, and of the abkarry or excise duties on consumable articles 594,103.

BAHIR, a Hebrew term signifying "famous" or "illustrious," but particularly applied to a book of the Jews, treating of the profound mysteries of the Cabala, being the most ancient of the rabbinical works.

BAHLINGEN, a bailiwick in the circle of Schwartzwald, or the Black Forest, in the kingdom of Wirtemberg. It extends over 132 square miles, and comprehends two cities, one market-town, and thirty-five villages, with 28,164 inhabitants. Its agriculture is little productive, but manufactures of various kinds are more advanced. The city, which gives name to the bailiwick, is on the Eynach, and contains 3220 inhabitants. Long. 8. 45. 52. E. Lat. 48. 16. 0. N.

BAHREIN, a cluster of islands on the south-west side of the Persian Gulf, near the Arabian shore, the principal of which is named Bahrein. This island, which is about fifteen miles from the coast, is one of the finest in the gulf, and is covered with villages and date gardens. The town and fort of Medina, which contains about 800 or 900 houses, carries on a considerable trade with Bussora and other ports in the gulf. Here is a harbour admitting vessels of 200 tons, which trade to Bushire, and with a fair wind make the voyage in fourteen hours. This island has always been famous for the pearl fishery carried on in its neighbourhood. The oyster banks produce the finest pearls in the world. They are found in a small muscle attached to the bottom by a thin fibre of great length, which is cut by the diver. These pearls are of two sorts, white and yellow; and are sent to India, and through Bussora and Bagdad into Asia. The fishery is farmed out by the different chiefs on the coast, who draw a large revenue from this source. These islands once belonged to the Portuguese. They afterwards fell under the dominion of an Arabian chief, from whom they were seized by the Persians. They were afterwards taken possession of by the Wahabees.

BAHRY, a town of Hindostan, in the province of Agra, ten miles to the north of the Chumbul. It is a town of some consequence; many of the houses are two stories in height, and have a greater appearance of comfort than is usual in Indian towns. It is chiefly inhabited by Patans, and is distinguished by several handsome Mahomedan tombs. Long. 77. 35. E. Lat. 26. 47. N.

BAHUS, a strong town of Sweden, and capital of a government of the same name, seated on a rock in a small island. Long. 11. 10. E. Lat. 57. 52. N.

BAIÆ, an ancient village of Campania, in Italy, situated between the promontory of Misenum and Puteoli, on the Sinus Batanus, and famous for its natural hot baths, which served the wealthier Romans for the purposes both of medicine and pleasure. The variety of these baths, the softness of its climate, and the beauty of its landscape, captivated the minds of opulent nobles, whose passion for bathing knew no bounds. Abundance of linen, and disuse of unguents, render the practice less necessary in modern life; but the ancients performed no exercise and engaged

Baiæ
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Bajazet.

in no study without previous ablutions, which at Rome required an enormous expense in aqueducts, stoves, and attendants; and therefore a place where waters naturally heated to every degree of temperature bubble spontaneously out of the ground, in the pleasantest of all situations, formed a treasure which could not be overlooked. Such was Baiæ in the highest perfection: its easy communication with Rome was also a great advantage. Hither retired for temporary relaxation the mighty rulers of the world, to recruit their strength and revive their spirits, fatigued with bloody campaigns and civil contests. Their habitations at first were small and modest; but increasing luxury soon added palace to palace with such expedition, that ground could no longer be had for new erections; while enterprising architects, supported by boundless wealth, carried their foundations into the sea, and drove that element back from its ancient limits. From being a place of occasional resort for a season, Baiæ now grew up into a regular city; and whoever found himself disqualified by age or infirmity for any longer sustaining an active part on the political theatre; whoever, from indolence of disposition, sought a place where the pleasures of a town were combined with the sweets of rural life; whoever wished to withdraw from the dangerous neighbourhood of a court, and the baneful eye of informers, flocked hither to enjoy life untainted with fear or trouble. Such a confluence of wealthy inhabitants rendered Baiæ as much a miracle of art as it had before been of nature; and its splendour may still be inferred from its innumerable ruins, heaps of marbles, mosaics, stucco, and other precious fragments of taste. It flourished in undiminished magnificence till the days of Theodoric the Goth; but the destruction of these enchanted palaces followed quickly upon the irruption of the northern conquerors, who overturned the Roman power, sacked and burned all before them, and destroyed or dispersed the whole race of nobility. Loss of fortune left the Romans neither the means nor indeed the thought of supporting such expensive establishments, which can only be enjoyed in perfection during peace and prosperity. No sooner had opulence failed, and the guardian hand of man been withdrawn, than the sea rushed back upon its old domain; moles and buttresses were torn asunder and washed away; and promontories, with the proud towers that once crowned their brows, were undermined and tumbled into the deep. Yet, in its ruined state, and stripped of all its ornaments, Baiæ still presents many striking objects for the admiration of the traveller and the pencil of the artist. Long. 14. 45. E. Lat. 41. 6. N.

BAJAZET I. sultan of the Turks, a renowned warrior, but a tyrant, was conquered by Timour, otherwise called Tamerlane, and exposed by him in an iron cage; the fate it is said which he had destined for his adversary if he had proved the victor. The iron cage, however, so long and so often repeated as a moral lesson, has been rejected as a fable by modern writers, who appeal to the Persian history of Sherefeddin Ali in support of their scepticism. Of this work a French version has been given, and from it Mr Gibbon has collected the following more specious narrative of this memorable transaction:—"No sooner was Timour informed that the captive Ottoman was at the door of his tent, than he graciously stepped forwards to receive him, seated him by his side, and mingled with just reproaches a soothing pity for his rank and misfortune. 'Alas,' said the emperor, 'the decree of fate is now accomplished by your own fault: it is the web which you have woven, the thorns of the tree which yourself have planted. I wished to spare, and even to assist, the champion of the Moslems: you braved our threats; you despised our friendship; you forced us to enter your kingdom

Bajazet with our invincible armies. Behold the event. Had you vanquished, I am not ignorant of the fate which you reserved for myself and my troops. But I disdain to retaliate: your life and honour are secure; and I shall express my gratitude to God by my clemency to man.' The royal captive showed some signs of repentance, accepted the humiliation of a robe of honour, and embraced with tears his son Mousa, who, at his request, was sought and found among the captives of the field. The Ottoman princes were lodged in a splendid pavilion; and the respect of the guards could be surpassed only by their vigilance. On the arrival of the harem from Bursa, Timour restored the queen Despina and her daughter to their father and husband; but he piously required that the Serbian princess, who had hitherto been indulged in the profession of Christianity, should embrace without delay the religion of the prophet. In the feast of victory, to which Bajazet was invited, the Mogul emperor placed a crown on his head and a sceptre in his hand, with a solemn assurance of restoring him with an increase of glory to the throne of his ancestors. But the effect of this promise was disappointed by the sultan's untimely death: amidst the care of the most skilful physicians, he expired of an apoplexy at Akshehr, the Antioch of Pisidia, about nine months after his defeat. The victor dropped a tear over his grave: his body, with royal pomp, was conveyed to the mausoleum which he had erected at Bursa; and his son Mousa, after receiving a rich present of gold and jewels, of horses and arms, was invested by a patent in red ink with the kingdom of Anatolia. Such is the portrait of a generous conqueror, which has been extracted from his own memorials, and dedicated to his son and grandson, nineteen years after his decease; and, at a time when the truth was remembered by thousands, a manifest falsehood would have implied a satire on his real conduct. On the other hand, of the harsh and ignominious treatment of Bajazet there is also a variety of evidence. The Turkish annals in particular, which have been consulted or transcribed by Leunclavius, Pocock, and Cantemir, unanimously deplore the captivity of the iron cage; and some credit may be allowed to national historians, who cannot stigmatize the Tartar without uncovering the shame of their king and country." From these opposite premises, Mr Gibbon thinks a fair and moderate conclusion may be deduced. He is satisfied that Sherefeddin Ali has faithfully described the first ostentatious interview, in which the conqueror, whose spirits were harmonized by success, affected the character of generosity. But his mind was insensibly alienated by the unseasonable arrogance of Bajazet; the complaints of his enemies, the Anatolian princes, were just and vehement; and Timour betrayed a design of leading his royal captive in triumph to Samarcand. An attempt to facilitate his escape by digging a mine underneath the tent, provoked the Mogul emperor to impose a harsher restraint; and in his perpetual marches an iron cage on a waggon might be invented, not as a wanton insult, but as a rigorous precaution. Timour had read in some fabulous history a similar treatment of one of his predecessors, a king of Persia; and Bajazet was condemned to represent the person and expiate the guilt of the Roman Cæsar. But the strength of his mind and body fainted under the trial, and his premature death might without injustice be ascribed to the severity of Timour.

BAIHINGEN, a bailiwick of the kingdom of Wirtemberg, in the circle of the Neckar. It extends over seventy square miles, and comprehends three cities, two market-towns, and sixteen villages, with 20,146 inhabitants. The city which gives name to the bailiwick is on the river Ens, and contains a castle, a church with some ancient monuments of the former counts of Bahin, and 3105 in-

habitants, who cultivate extensively the vine. Long. 8. 47. 50. E. Lat. 48. 55. 45. N.

BAIKAL, a great lake of Siberia, in the government of Irkutsk, 366 miles in length from south-west to north-east, and from twenty to fifty-three miles in breadth. This vast reservoir is, according to accurate observations, about 1715 feet above the level of the sea. It is fed by several large rivers, namely, the Upper Angara, Selenga, Bargazin, and others; while the only visible outlet is by the Lower Angara, which is incapable of carrying off any thing like the quantity of water which is received. The water is excellent and extremely clear, so that the bottom can be seen at the depth of eight fathoms. The depth of the lake varies from twenty-two to ninety fathoms. It yields abundance of fish, and there is a profitable fishery of seals on its shores during the whole summer. The climate is extremely severe; the waters of this great inland sea are frozen over about the beginning of January, and the ice does not break up till May. This lake facilitates the Russian trade with China, and also between Irkutsk and Dauria. It is navigated by the Russians in summer, and in winter they travel across it on the ice. Several hot springs and mineral waters are seen on the margin, and naphtha is sometimes found floating on the surface. It lies between the 52d and 55th degrees of north latitude.

BAIL, BALLIUM (from the French *bailler*, which is derived from the Greek *βαλλειν*, and signifies to deliver into hands), is used in our common law for the freeing or setting at liberty of one arrested or imprisoned upon any action, either civil or criminal, on surety taken for his appearance at a day and place certain.

BAILIFF, or BAILIE, in a general sense, denotes an officer appointed for the administration of justice in a certain district or bailiwick. The term is formed from the French word *bailiff*, that is, *præfectus provinciae*. The chief magistrates in divers towns are called bailiffs or bailies; and sometimes the persons to whom the king's castles are committed are termed bailiffs, as the *bailiff of Dover Castle*.

Of ordinary bailiffs there are several sorts, viz. sheriffs' bailiffs, bailiffs of liberties, &c. Sheriffs' bailiffs, or sheriffs' officers, are either bailiffs of hundreds or special bailiffs. Bailiffs of hundreds are officers appointed over those districts by the sheriffs, to collect fines, to summon juries, to attend the judges and justices at the assizes and quarter-sessions, and also to execute writs and process in the several hundreds. Bailiffs of liberties were those bailiffs appointed by every lord within his liberty, to execute process, and do such offices as the bailiffs-errant were wont to do at large in the county.

BAILLI, DAVID, painter of perspective views and portraits, was the son of Peter Bailii, an artist of some note, and was born at Leyden in 1584. From his father he learned to draw and design; but he was afterwards placed under the care of Adrian Verburg, and continued with him for some time; and when he quitted that master, he studied to much greater advantage with Cornelius Vandervoort, an excellent portrait painter, and with him he spent about six years. As Vandervoort possessed many capital paintings of some great masters, Bailii, for his own improvement, copied them with critical care and observation; and particularly copied one perspective view of the inside of a church, originally painted by Stenwyck, which he finished with such accuracy, that even Stenwyck himself could scarcely determine which was the original or which the copy, when both were placed before him. He travelled through several parts of Italy to see the works of the celebrated masters of that country, and resided a few years at Rome; and abroad, as well as in his own country, the correctness of his drawing, and the delicate

Bajazet
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Baihingen.

Baikal
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Bailii.

Bailiwick
Baillie.

handling of his pictures, procured him employment, admirers, and friends. In the latter part of his life he discontinued painting, and only drew portraits on vellum with a pen, which he heightened with black lead, and thus gave them wonderful force and roundness. He died in 1638.

BAILIWICK, that liberty which is exempted from the jurisdiction of the sheriff of the county, and over which liberty the lord thereof appoints his own bailiff, with the like power within his precinct as an under-sheriff exercises under the sheriff of the county. Or it signifies the precinct of a bailiff, or the place within which his jurisdiction is terminated.

BAILLET, **ADRIAN**, a very learned French writer and critic, born in June 1649, at the village of Neuville, near Beauvais, in Picardy. His parents were too poor to give him a proper education, which, however, he obtained by the favour of the bishop of Beauvais, who afterwards presented him with a small vicarage. In 1680 he was appointed librarian to M. de Lamoignon, advocate-general to the parliament of Paris, of whose library he made a copious index in thirty-five volumes folio, all written with his own hand. He died in January 1706. In the list of his numerous works the following are the most conspicuous:—1. *Histoire de Hollande depuis 1609 jusqu'à 1690*, 4 tom. 12mo. This work was published under the name of Neuville. 2. *Les Vies des Saints*, 3 tom. fol. 3. *Des Enfants devenus célèbres par leurs Etudes et par leurs Ecrits*, 2 tom. 12mo. 4. *Vie de Descartes*, 2 tom. 4to. 5. *Jugemens des Savants sur les principaux Ouvrages des Auteurs*, 9 tom. 12mo. The last is the most celebrated and the most useful of all the works of this learned and indefatigable writer. The edition of it published in 1722 by M. de la Monnoye, in seven volumes quarto, contains the *Anti-Baillet* of M. Menage, besides notes; but the editions subsequently published in Holland are esteemed still more complete.

BAILLEUL, a town of France, in the department of the North, formerly very strong, but now without any fortifications. Long. 2. 45. E. Lat. 50. 45. N.

BAILLIE, **ROBERT**, one of the most learned men among the Scottish presbyterians of the seventeenth century, was born at Glasgow in the year 1599. His father, who is described as a citizen, was a son of Baillie of Jerviston, who belonged to the family of Carphin, a branch of the ancient family of Lamington, in the county of Lanark; his mother was Helen Gibson, connected with the Gibsons of Durie, one of whom was an eminent judge in the supreme court. In the year 1617 he was matriculated in the university of Glasgow, under the name of *Robertus Baillize*; and here it may be remarked that, according to the careless practice of the age, he afterwards exhibited no small variety in the orthography of his surname, writing it Baylie, Baily, Bailie, and Baillie. His studies were partly conducted under the superintendence of John Cameron, a man of great learning and reputation, who had been a professor in the protestant university of Saumur, and who in 1622 was appointed principal of the university of Glasgow. From him Baillie imbibed the doctrine of passive obedience; and, in consequence of this prejudice of education, he only gave a tardy assent to the strenuous measures which were afterwards adopted against Charles the First. Having taken the degree of A. M. he applied himself to the study of divinity, and in due time received ordination from Archbishop Law.

On the 16th of August 1626 he was admitted one of the regents of the university; and, on taking his chair, he delivered an inaugural oration *De Mente agente*. Dr Strang, a man of talents and learning, had been appointed principal a few months before. About the same period,

Baillie.

Baillie appears to have prosecuted the study of the oriental languages, in which he is allowed to have attained to no mean proficiency. He was anxious to promote similar studies in the university; and in the year 1629 he delivered an oration *In Laudem Linguae Hebraeae*.

One of the pupils intrusted to his charge was Lord Montgomery, eldest son to the earl of Eglintoun, by whom he was presented to the living of Kilwinning in Ayrshire. His induction must have taken place between 1630 and 1632. With this noble family he continued to live on terms of intimacy; and as he was a person of excellent character, he equally enjoyed the approbation of his own parishioners, and the confidence of his ordinary the archbishop of Glasgow. In 1633 he declined the offer of a living in Edinburgh. Between 1634 and 1636 he was much employed in discussing, by means of private correspondence with his brethren, certain questions respecting Arminianism, and the ceremonies obtruded on the church by the partisans of Laud. In 1638 the presbytery of Irvine elected him a member of the assembly which was held at Glasgow, and which laid the foundation of material changes in church and state. During the ensuing year his countrymen raised a considerable army, which was placed under the command of Alexander Leslie, an old and experienced officer; and Baillie appears to have caught some portion of the military ardour which now prevailed in this cause of religion and liberty. "It would have done you good," he remarks in one of his letters, "to have cast your eyes athort our brave and rich hills as oft as I did, with greater contentment and joy; for I was there among the rest, being chosen preacher by the gentlemen of our shire, who came late with Lord Eglinton. I furnished to half a dozen of good fellows, muskets and pikes, and to my boy a broad sword. I carried myself, as the fashion was, a sword, and a couple of Dutch pistols at my saddle; but, I promise, for the offence of no man, except a robber in the way; for it was our part alone to pray and preach for the encouragement of our countrymen, which I did to my power most chearfully." (*Letters*, vol. i. p. 174.) He afterwards states, "Our soldiers grew in experience of arms, in courage, in favour, daily. Every one encouraged another. The sight of the nobles, and their beloved pastors, daily raised their hearts. The good sermons and prayers, morning and evening, under the roof of heaven, to which their drums did call them for bells; the remonstrances very frequent of the goodness of their cause; of their conduct hitherto, by a hand clearly divine; also Lesly's skill, and prudence, and fortune, made them as resolute for battle as could be wished. We were feared that emulation among our nobles might have done harm, when they should be met in the field; but such was the wisdom and authority of that old, little, crooked soldier, that all, with an incredible submission, from the beginning to the end, gave over themselves to be guided by him, as if he had been great Solymán.... Had you lent your ear in the morning, or especially at even, and heard in the tents the sound of some singing psalms, some praying, and some reading Scripture, ye would have been refreshed. True, there was swearing, and cursing, and brawling, in some quarters, whereat we were grieved; but we hoped, if our camp had been a little settled, to have gotten some way for these misorders; for all of any fashion did regret, and all promised to do their best endeavours for helping all abuses. For myself, I never found my mind in better temper than it was all that time since I came from home, till my head was again homeward; for I was as a man who had taken my leave from the world, and was resolved to die in that service without return." This enthusiastic army had advanced to the borders of the kingdom, and had pitched its camp on Dunse Law; the royal forces were

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within a very short distance; and the adverse parties were on the eve of a general engagement, when the treaty of Berwick, negotiated with Charles in person, produced a temporary cessation of open hostilities. But the seeds of dissension were too widely scattered, and had taken too deep root, to be so speedily checked in their growth: the notions of the king, sufficiently arbitrary in themselves, were at variance with the elastic spirit of the age; and his subjects, in both divisions of the island, were gradually impressed with a deep conviction of his insincerity. In the year 1640 the Covenanters again had recourse to arms; and having invaded England, they took the town of Newcastle. Baillie now resumed his attendance in the camp; and before the close of the year he was employed in London, along with other commissioners, in preparing charges against Archbishop Laud, for the innovations which he had obtruded on the church of Scotland. He had very recently published *The Canterburian's Self-Conviction*, which seems to have been industriously circulated, and which arrived at a fourth edition. About this period of his life he composed various other works of a controversial nature, and was regarded as one of the most strenuous defenders of the presbyterian cause.

His merit was now so conspicuous that he was offered a professorship in each of the four universities. Having been appointed one of the professors of divinity at Glasgow, he delivered, on the 6th of July 1642, an inaugural oration *De Hæreticorum Autocatacrisi*. About this period he must have taken the degree of D.D.; for the records of the university describe him as "Doctor et Professor SS. Theologiæ." His colleague David Dickson, who had been appointed in 1640, is described in the same manner; but neither of them assumed the title of doctor in his printed works. Both professors discharged the functions of clergymen in the city; and in such of his publications as bear the author's name, Baillie styles himself minister at Glasgow, or minister of the gospel at Glasgow, without any addition. While he filled this chair, it is to be inferred that his chief employment consisted in teaching the oriental languages. Dr Dickson having been removed to the university of Edinburgh, he was admitted to the higher professorship of divinity on the 17th of January 1651. His labours were various and extensive. He was much engaged in the public affairs of the church, and was a member of all the general assemblies from 1638 to 1653, with the exception of those which were held during his attendance at Westminster. In 1642 the assembly appointed him to visit and preach in the north of Ireland during four months. To the assembly of Westminster, which commenced its sittings in the year 1643, the church of Scotland sent Alexander Henderson, Robert Douglas, Samuel Rutherford, Robert Baillie, and George Gillespie, together with three ruling elders, the Earl of Cassilis, Lord Maitland, and Sir Archibald Johnston of Warriston. Of the proceedings of this ecclesiastical council, Baillie has given an interesting account in his correspondence. His modest opinion of himself, and his high estimate of his colleagues, are equally conspicuous. "These things are so high, and of so great concernment,"

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he remarks in a letter to Robert Blair, "that no living man can think Mr Henderson may be away; and to put him to go and return, it were very hard to venture such a jewel, that is so necessary to the well-being both of church and state of all these dominions. Mr Samuel, for the great parts God has given him, and special acquaintance with the question in hand, is very necessary to be here. ...Mr G. Gillespie, however I had a good opinion of his gifts, yet I profess he has much deceived me. Of a truth there is no man whose parts in a publick dispute I do so admire. He has studied so accurately all the points ever yet came to our assembly, he has gotten so ready, so assured, so solid a way of publick debating, that however there be in the assembly divers very excellent men, yet, in my poor judgement, there is not one who speaks more rationally, and to the point, than that brave youth has done ever; so that his absence would be prejudicial to our whole cause, and unpleasant to all here that wishes it well." (*Letters*, vol. i. p. 451.) In 1645 he returned from England, in order to give to the general assembly an account of the proceedings at Westminster; and having resumed his station among the assembled divines, he continued to reside for some time longer in the English metropolis.¹ He now stood very high in the esteem and confidence of his countrymen; and in 1649 he was one of the commissioners sent to Holland for the purpose of inviting Charles II., and of settling the terms of his admission to the government. In the controversy which prevailed among the presbyterians between 1650 and 1660, he adhered to the party of the Resolutioners against that of the Protesters. The commission of the general assembly had adopted two *resolutions*, by which they consented to the repeal of the act for reforming the army, and the act by which certain classes of persons were excluded from places of power and trust, on account of their immoral conduct, or of the opposition which they had evinced towards the cause of civil and religious reform; and the resolutions having been approved by two subsequent assemblies, a formal *protest* against the constitution and proceedings of those assemblies was entered by various ministers and elders.

After the restoration, Patrick Gillespie, who had enjoyed the special favour of Cromwell, was ejected from his office; and on the 23d of January 1661 Baillie was admitted as principal of the university of Glasgow. For this promotion he was indebted to Lauderdale, who had not yet appeared in his true and hideous colours. According to some writers, he might have exchanged his academical office for a bishopric; but he was deeply grieved at the establishment of episcopacy, and would not accept of preferment in the church. When the new archbishop of Glasgow, Andrew Fairfoul, arrived at his metropolitan seat, he did not fail to pay his respects to the learned principal. Baillie admits that "he preached on the Sunday, soberly and well." "The chancellor, my noble kind scholar," he afterwards states, "brought all in to see me in my chamber, where I gave them sack and ale the best of the town. The bishop was very courteous to me. I excused my not using of his styles, and professed my

¹ The following passage occurs in a letter, dated at Glasgow on the 22d of August 1654, and addressed to the famous Dr Fuller: "Having lately, and but lately, gone through your Holy Warr and Description of Palestine, I am fallen so in love with your pen, that I am sorie I wes not before acquaint with it, and with your self, when from the 1643 to 1647 I lived at Worcester house, and preached in the Savoy, that then, when I had some credite there, I might have used my best endeavours to have done yow pleasure." (Baillie's *MS. Letters*, vol. iv. p. 423.) Of the pulpit-oratory, and of the general talents of the Scottish divines who visited London, the Earl of Clarendon and Mr Hume have given the same unfavourable account; but on this subject, as well as on many others, their opinion is strongly contested by Mr Brodie. "These famous divines preached as chaplains, by turns, in one of the lecture-rooms; and, as was to have been expected at such a juncture from men of their reputation, capacity, and profound as well as varied erudition, they drew immense crowds. If we may form an estimate of their pulpit-oratory from their works, we may safely pronounce that the English did not discredit themselves by flocking to hear such preachers." (*History of the British Empire*, vol. iii. p. 41.)

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utter difference from his way, yet behoved to intreat his favour for our affairs of the college; wherein he promised liberally. What he will perform, time will try." (*Letters*, vol. ii. p. 461.) According to another account, the archbishop visited him during his illness, and was accosted in the following terms:—"Mr Andrew, I will not call you my Lord. King Charles would have made me one of these lords; but I do not find in the New Testament that Christ has any lords in his house." In other respects he is said to have treated the prelate very courteously; and it may not be superfluous to remark, that this mode of using the Christian name instead of the surname was not unusual at that period. Baillie died in the month of July 1662, at the age of sixty-three.

His first wife was Lilius Fleming, of the family of Cardarroch, in the parish of Cadder, near Glasgow. Of this marriage there were many children, but only five survived him. 1. Henry, a clergyman, who was never beneficed. His posterity inherited the estate of Carnbroe, which was recently sold by General Baillie. 2. Lilius, married to Eccles of Kildonan in Ayrshire. 3. Helen, married to a baillie of Glasgow, named Colquhoun. 4. Elizabeth, married to Mr Hamilton, a gentleman of Strathbane in the kingdom of Ireland. 5. Mary, married to Walter Buchanan of Orchard. The mother of these children died on the 7th of June 1653, after a lingering illness. She is mentioned by her husband in terms of much respect and affection. On the 1st of October 1656 he married Mrs Wilkie, who was a widow, and the daughter of Dr Strang. The issue of this marriage was Margaret, who became the wife of Walkingshaw of Borrowfield.

Wodrow, the zealous and faithful historian of the persecuted church of Scotland, has formed a very high estimate of Baillie's literary character. "Mr Robert Baillie may most justly be reckoned among the great men of this time, and was an honour to his country, for his profound and universal learning, his exact and solid judgement, that vast variety of languages he understood, to the number of twelve or thirteen, and his writing a Latin style which might have become the Augustan age."¹ This commendation of his Latinity may admit of some abatement; for although he evidently possessed a very familiar knowledge of the language, his Latin style cannot safely be said to reach the standard of ancient purity and elegance. An episcopalian writer, the author of the Appendix to Spotswood, has commemorated Baillie as "a learned and modest man: though he published some very violent writings, yet those flowed rather from the instigation of other persons, than his own inclinations."² Mr Brodie, a recent historian of much ability and research, bestows the following commendation on Baillie and his associates. "The clergy, on whom they greatly depended, were profound scholars, and no despicable politicians. Nothing can be more misplaced than the ridicule which has been so profusely levelled at that body. They proved themselves ambitious; but, to be satisfied of their talents, and to admire their knowledge, it is only necessary to peruse their works. The writings of Baillie, even his familiar letters, breathe a manliness of spirit, and evince intelligence and erudition, that must for ever rescue from contempt a class

of which he did not conceive himself entitled to rank at the head."³

Baillie had devoted much attention to the study of the oriental languages, and was skilled in Hebrew, Chaldee, Syriac, Samaritan, Arabic, and Ethiopic. In his correspondence with the scholars of the continent, he urged Golius, Buxtorf, and other learned men, to compose elementary works on such of these languages as were not already provided with them. In an unpublished letter, dated at Glasgow on the 27th of August 1656, and addressed to Mr Crawford, a minister of London, he remarks, "The reason of my calling to you at this tyme is my desyre to know the condition of that excellent book, the best to me that ever was printed, Dr Walton's Polyglott Bible." He was solicitous that the learned protestants should undertake an Encyclopædia of arts and sciences; and urged his correspondents not to permit the education of youth, and the composition of books for elementary instruction, to be so generally engrossed by the Jesuits.

Of Baillie's publications, the following is as complete a list as we have been able to furnish.

1. *Ladensium Αυτοκατακρισις*, the *Canterbrians Self-Conviction*; or, an evident Demonstration of the avowed Arminianisme, Poperie, and Tyrannie of that Faction, by their owne confessions: with a postscript to the personat Jesuite Lysimachus Nicanor,⁴ a prime *Canterburian*. *Written in March, and printed in Aprile, 1640, 4to.*—This book was speedily reprinted at Amsterdam; and a "third edition, augmented by the author, with a large Supplement," was printed for Nathaniel Butter, 1641, 4to. The additional part was likewise published in a separate form, under the title of "A large Supplement of the *Canterbrian Self-Conviction*." *Imprinted 1641, 4to.* A fourth edition of the work bears the title of "The Life of William now Lord Arch-bishop of *Canterbry*, examined." *Lond. 1643, 4to.*

2. A Parallel or briefe Comparison of the Liturgie with the Masse-Book, the Breviarie, the Ceremoniall, and other Romish Ritualls.⁵ *Lond. 1641, 4to.* Reprinted in 1661.

3. *Queries anent the Service-Book.*

4. *An Antidote against Arminianism.*

5. *The Unlawfulness and Danger of limited Episcopacie*; whereunto is subjoined a short Reply to the modest Advertiser and calm Examiner of that Treatise: as also the Question of Episcopacie discussed from Scripture and the Fathers. *Lond. 1641, 4to.*

6. *Satan the Leader in chief to all who resist the Reparation of Sion*; as it was cleared in a Sermon to the Honourable House of Commons at their late solemn Fast, Febr. 28, 1643. *Lond. 1643, 4to.*

7. *Errours and Induration are the great Sins and the great Judgements of the Time*: preached in a Sermon before the Right Honourable House of Peers, in the Abbey-Church at Westminster, July 30, 1645, the day of the monethly Fast. *Lond. 1645, 4to.*

8. *A Dissvative from the Errours of the Time*: wherein the Tenets of the principall Sects, especially of the Independents, are drawn together in one Map, &c. *Lond. 1645, 4to.* *Lond. 1646, 4to.*

¹ *Wodrow's History of the Sufferings of the Church of Scotland*, vol. i. p. 128. *Edinb. 1721-2, 2 vols. fol.*—See the same author's *Life of James Wodrow, A. M. Professor of Divinity in the University of Glasgow*, p. 30. *Edinb. 1828, 12mo.*

² *T. Middleton's Appendix to the History of the Church of Scotland*, p. 23. *Lond. 1677, fol.*

³ *Brodie's Hist. of the British Empire*, vol. ii. p. 506.

⁴ The Epistle congratulatory of Lysimachus Nicanor, of the Societie of Jesu, to the Covenanters in Scotland; wherein is paralleled our sweet harmony and correspondency in divers materiall points of Doctrine and Practice. *Anno Domini 1640, 4to.*—The author of this Epistle was John Corbet, a Scottish clergyman, who having taken refuge in Ireland, was "hewed in pieces in the very armes of his poore wife." (*Baillie's Historical Vindication*, p. 2.) Some notices of him may be found in *Burnet's Life of Bishop Bedell*, p. 140. *Lond. 1685, 8vo.*

⁵ Some animadversions on this work are subjoined to L. Womock's *Beaten Oyle for the Lamps of the Sanctuarie*. *Lond. 1641, 4to.*

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- Baillie. 9. An Historical Vindication of the Government of the Church of Scotland, from the manifold base Calumnies which the most malignant of the Prelats did invent of old, and now lately have been published with great industry in two pamphlets at London; the one intituled *Issachars Burden*, &c., written and published at Oxford by John Maxwell,¹ a Scottish Prelate, &c. Lond. 1646, 4to.
10. Anabaptism, the true Fountaine of Independency, Brownisme, Antinomy, Familisme, &c. in a Second Part of the Disswasive from the Errors of the Time. Lond. 1647, 4to.
11. A Review of Doctor Bramble, late Bishop of Londonderry, his Faire Warning against the Scotese Disciplin. Delf, 1649, 4to.—This tract was afterwards incorporated, without being reprinted, in a collection entitled *Three Treatises concerning the Scottish Discipline*. Hagh, 1661, 4to. The other two treatises are Bramhall's Fair Warning and Watson's Second Fair Warning, in answer to Baillie; and the volume likewise includes a virulent epistle by another Scottish writer, Dr Creighton, afterwards bishop of Bath and Wells. Baillie's Review was reprinted at Edinburgh; and having been translated into Dutch, it was published at Utrecht under the inspection of Gisbert Voet.
12. A Scotch Antidote against the English Infection of Arminianism. Lond. 1652, 12mo.
13. Appendix practica ad Joannis Buxtorfii Epitomen Grammaticæ Hebrææ. Edinb. 1653, 8vo.
14. Catechesis elenctica Errorum qui hodie vexant Ecclesiam; ex nudis sacræ Scripturæ Testimoniis, in brevibus et claris Quæstionibus ac Responsionibus proposita, in gratiam studiosæ Juventutis Academiæ Glasguensis. Lond. 1654, 12mo.
15. A Reply to the Modest Inquirer.—Perhaps relating to the dispute between the Resolutioners and Protesters. This tract, together with numbers 3 and 4, we have not seen. They are all mentioned in Baillie's papers, in the possession of Dr M'Crie.
16. The Disswasive from the Errors of the Time, vindicated from the Exceptions of Mr Cotton and Mr Tombes. Lond. 1655, 4to.
17. Operis Historici et Chronologici libri duo; in quibus Historia sacra et profana compendiose deducitur ex ipsis Fontibus, a Creatione Mundi ad Constantinum Magnum. Amstelodami, 1663, fol.—Some copies have the addition of an index, with a new title bearing the date of 1668.
18. Letters and Journals; containing an impartial Account of public Transactions, civil, ecclesiastical, and military, in England and Scotland, from the beginning of the Civil Wars in 1637, to the year 1662; a period, perhaps, the most remarkable and interesting in the British History: now first published from the manuscripts of Robert Baillie, D. D. Principal of the University of Glasgow. Edinb. 1775, 2 vols. 8vo.—Some copies, bearing the same date, have a different title, which states that the Letters were "carefully transcribed by Robert Aiken." Many of them are addressed to the author's cousin-german William Spang, minister of the Scottish staple at
- Campvere, and afterwards of the English congregation at Middelburg in Zeeland. It was chiefly from the materials thus communicated that Spang prepared two different publications. The first is entitled "Brevis et fidelis Narratio Motuum in Regno et Ecclesia Scoticana, excerpta ex scriptis utriusque partis scitu dignissimis, per Irenæum Philalethen." Dantisci, 1640, 4to. This work only prosecutes the narrative till the first of October 1638; but he speedily reprinted it, and added a continuation to the year 1640. "Rerum nuper in Regno Scotiæ gestarum Historia." Dantisci, 1641, 8vo.—These letters were published from a copy belonging to Matthew Baillie of Carnbroe, Esq.; and the editor likewise consulted the copy preserved among the archives of the church of Scotland. The copy which belonged to the author's family is now in the possession of Dr M'Crie, to whose kindness we are indebted for the use of it, as well as for several biographical notices. This manuscript consists of four volumes in folio, and is in a tolerably good state of preservation. Baillie's Letters and Journals are of great historical value; and as the editor, besides omitting many detached passages, has suppressed a considerable number of entire letters, we beg leave to suggest, and even to urge, the expediency of a new and complete edition.
- Baillie had apparently some concern in the publication of a posthumous work of his learned predecessor Robert Boyd, principal of the university of Glasgow: *In Epistolam Pauli Apostoli ad Ephesios Prælectiones supra cæ.* Lond. 1652, fol. Prefixed is a life of the author by Rivet, with whom Boyd had been intimately acquainted; but the preface is subscribed with the initials R. B. A biographical notice, bearing the same signature, is prefixed to the work of his father-in-law Dr Strang, *De Interpretatione et Perfectione Scripturæ.* Roter. 1663, 4to. (x.)
- BAILLY, JEAN SYLVAIN, a celebrated philosopher and astronomer, was born at Paris on the 15th of September 1736. He was originally intended for the profession of painting, which his family had pursued for several generations, and he even had made some progress in the art. But the bias of his mind leaned too much to literary pursuits, especially to poetry and works of imagination, to permit him to give that application which is necessary to secure success and eminence in any profession.
- The friends of Bailly, who had witnessed the early dawn of his genius, saw that it was alike fitted to appear with advantage in the study of polite literature, or to shine in the walks of science; and they recommended the latter chiefly to his attention. His acquaintance with Lacaille, the celebrated geometer, commenced; and this at once decided the object of his studies, which were now almost entirely devoted to scientific investigations. The first of his labours was a calculation of the comet which appeared in the year 1759. In January 1763 he was admitted a member of the Academy of Sciences; and in the same year he published a reduction of the observations made by Lacaille in 1760 and 1761 on the zodiacal stars: an elaborate compilation, and of very extensive utility. His attention was afterwards directed to the consideration of the theory of Jupiter's satellites. Lagrange, who now pro-

¹ John Maxwell, D. D., was the son of Maxwell of Cavons in Nithsdale; and after having been beneficed at Murthlack and in Edinburgh, he became bishop of Ross in the year 1633. He was deposed and excommunicated by the assembly of 1638, and took refuge in England. In 1640 he was appointed bishop of Killala in Ireland; but the rebellion speedily ensued, and after being stripped naked and severely wounded, he was again compelled to seek a place of refuge in England, and for some time he attended the king at Oxford. In 1645 he was appointed archbishop of Tuam, and died on the 14th of February 1646. The work which Baillie answered is entitled "The Burthen of Issachar: or, the Tyrannical Power and Practises of the Presbyterian Government in Scotland." Printed in the year 1646, 4to. Dr Maxwell is the author of another work, which was answered by Rutherford: "*Sacro-sancta Regum Majestas*; or, the sacred and royall Prerogative of Christian Kings." Oxford, 1644, 4to. According to Bishop Burnet, he was "a man of eminent parts, and an excellent preacher; but by his forwardness and aspiring he was the unhappy instrument of that which brought on all the disorders in Scotland." (*Life of Bishop Bedell*, p. 141.) He is mentioned and described in the Life, Diary and Correspondence of Sir William Dugdale, p. 437. Lond. 1827, 4to.

Bailly. mised to become the first mathematician in Europe, was the formidable rival of Bailly in the competition for this prize question in 1764. The results of his investigations were collected into a treatise, which also contained the history of that part of astronomy, and were published in 1766. In 1771 appeared his interesting and important memoir on the Light of the Satellites, which was marked with a degree of precision and accuracy till that time unknown in the observations of their eclipses.

The studies of Bailly were not entirely limited to the cultivation of abstract science, nor to profound physical speculations; his genius shone with equal lustre in those departments of literature which require a discrimination of character, and no common powers of eloquence, in order to attain excellence. His *Eloges* on Charles V., Corneille, Leibnitz, Molière, Cook, Lacaille, and Gresset, were universally admired as valuable specimens of fine writing, and they added much to his reputation. The distinguished place of secretary of the Academy of Sciences became vacant in 1771; and, supported by the patronage and influence of Buffon, he offered himself a candidate. But, in this instance, he was unsuccessful. Condorcet, then rising into reputation, and supported by the active influence of D'Alembert, was preferred to the office.

In the year 1775 he published at Paris the first volume of his great work, the *History of Astronomy*, containing the history of astronomy from its origin to the foundation of the Alexandrian School; and this was followed by three volumes on the history of modern astronomy, published between 1776 and 1783. This work, which is of inestimable value, is distinguished alike for animated description, luminous narration, and interesting detail. Besides, he published, in 1777, a work entitled *Letters on the Origin of the Sciences, and of the People of Asia*; and this was followed by another series of *Letters on the Atlantis of Plato, and the Ancient History of Asia*, as a continuation of the same work. These volumes were addressed to Voltaire, with whom he had commenced an ingenious correspondence and discussion on this curious subject. The coincidence of his opinions with those of Buffon in points respecting some of the favourite theories of the latter, brought on an intimate acquaintance and close friendship with that celebrated naturalist; which, however, declined and was entirely dissolved, in consequence of the opposition which Bailly made to the election of the Abbé Maury into the French Academy. Bailly had been chosen secretary of the academy in 1784; and in the following year he was admitted into the Academy of Inscriptions and Belles Lettres. This was the only instance, since the time of Fontenelle, of the same person being at once a member of all the three academies.

In the year 1784 he was nominated one of the commission to investigate the nature of the animal magnetism of Mesmer; and he drew up a very elegant report, which was presented to the academy of Sciences. This report, which was soon afterwards translated into English, not only marked the acuteness and discernment of the author, and contained the most satisfactory and decisive evidence with regard to its object, but it may be held up as an excellent model of imitation for those who are engaged in similar investigations. In developing the physical effects produced by moral causes, it is of the greatest value; and it is particularly interesting when we consider the political influence which causes of this nature have exerted on the general opinions of society, and even on the destiny of nations.

In 1787 he published, in one volume 4to, the *History of Indian and Oriental Astronomy*; a work of great erudition and ability, but in which he is thought to have made some erroneous calculations, and to have overrated the antiquity of the Indian observations.

Hitherto we have contemplated Bailly in the shades of retirement, and in the calm undisturbed retreats of philosophy, employing the energy of a vigorous and comprehensive mind in the profound researches of physical truth. We are now to follow him in his political career, and to behold him struggling with the adverse interests of factions, and contending with the unbridled fury of a lawless mob, in defence of the rights of a people whose minds were not prepared to understand, and whose habits were not yet formed to enjoy, the blessings of rational liberty. He was one of the first and most zealous promoters of the revolution in France; and in the part which he acted in this bloody struggle, he has had the good fortune to be well spoken of by opposite factions. He has never been charged with want of integrity or with selfish designs; but apparently actuated by a misguided zeal, and dazzled with the prospect of freedom which the warmth of his imagination held out, he rashly committed himself in a cause which, as he had espoused it with enthusiasm, so he supported it with his utmost exertions. But in that cause he fell a sacrifice to the unrelenting spirit of violence and faction which had been easily roused, but which it was found impossible either to subdue or to regulate. When the states-general of France were assembled in 1789, he was elected a deputy to the *tiers-état*, of which he was afterwards chosen president; and when the national assembly had been constituted, he continued in the chair, and officiated as president at the time the king's proclamation was issued ordering that body to disperse. During the struggle which took place between the national assembly and the court, Bailly was amongst the most forward in asserting those popular rights which were then new in France; and it was he who dictated the famous oath to the members of the *tiers-état*, by which they pledged themselves "to resist tyrants and tyranny, and never to separate till they had obtained a free constitution." On the 14th of July following, the day on which the Bastille was stormed and taken by the people, he was appointed mayor of Paris with universal consent. In this high office he is allowed to have acted with great integrity, courage, and moderation, and to have discharged its arduous and sometimes perilous duties in a manner highly honourable to his character. While he held this conspicuous situation, he was instrumental in promoting the various measures by which the popular party at length prevailed over that of the court; for which, as well as for his conduct in other respects, he obtained a high degree of favour among the people. But the tide of public opinion now swelled beyond all bounds; and no restraint could oppose its violent course. The multitude, newly unshackled from the fetters of despotism, greedy of novelty, fired with enthusiastic and unsettled notions of freedom, and daily panting for change, would brook no opposition. Bailly, who now perhaps saw when it was too late the general disposition of the people to anarchy, still wished the laws to be respected, and hoped by their vigorous execution to restore and maintain tranquillity. He ordered some deputies from the military insurgents of Nancy to be arrested, and firmly opposed the rash proceedings of Marat and Hebert; he became a member of a less promiscuous club than that of the Jacobins; and he exerted himself strongly to persuade the populace to permit the king and royal family to depart to St Cloud. By these measures, which were little relished by a fickle and infuriated people, he lost their confidence and favour. But what finally destroyed his popularity, was his conduct on the occasion of the tumultuous meeting of the populace on the 17th of July 1791, to demand the abolition of monarchy; for being called by the national assembly to disperse the mob, who had assaulted the soldiery, he ordered

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the latter to fire, by which means forty persons were killed and above a hundred wounded. Having thus become obnoxious to the people, whom he had faithfully served, it was no longer desirable for him to hold his charge. He therefore resigned his office at the dissolution of the constituent assembly in the end of the year 1791; and having resumed his philosophical researches, lived for some time in retirement. But the times of bloody proscription approached; and he was doomed to fall a sacrifice to the ferocious vengeance of the plebeian tyrant who now bore unlimited sway. He was accordingly denounced as an enemy to the republic, arrested, and thrown into prison. Arraigned before a sanguinary tribunal, he was summarily condemned to death as a conspirator, and executed the day following, near the spot where he had given the order for the military to fire on the people. On the day of execution, his sufferings, which he bore with the utmost calmness and magnanimity, were studiously protracted. Instead of that sympathy and compassion which even the worst and the lowest criminal often experiences when he is about to expiate his offences with his life, he was treated by an incensed and fanatical populace with the most ignominious indignity and cruelty. He wore the red shirt, or badge of conspiracy, and was placed in a cart with his hands tied behind his back. During the whole time of his progress to the place of execution, the rain poured incessantly on his head. The populace, as he passed, threw mud at him, and cruelly insulted him with every kind of opprobrious language. Arrived at the place of execution, it was found necessary to remove the guillotine from the spot where it had first been erected, to firmer ground. During this time he was forced to get out of the cart, and walk round the field, in order to gratify more fully the implacable and unrelenting malice of the populace. While he was ascending the platform, a spectator who happened to be near him, exclaimed, in a tone of insult, "Bailly, you tremble!" "Yes," he instantly replied, "but it is from cold."

Several works written by Bailly, and found in manuscript, have been published since his death; particularly an *Essay on Fables and their History*, and *Memoirs of a Witness of the Revolution*, which come down to October 1789.

In his person Bailly was tall, and of a sedate but striking countenance. He possessed great firmness and decision of character; but in him these qualities were far removed from sullenness or apathy. Few philosophers have been more distinguished in so many various departments of science and literature, or have acquired such deserved reputation. In his public stations, as well as in the retirement of domestic life, his integrity and disinterestedness remained pure and untainted. In the time of his magistracy he spent part of his fortune in relieving the wants of the poor. His wife, whom he married in 1787, survived him. She was the widow of Raymond Gaye, who had been his intimate friend for twenty-five years.

BAILMENT, from the French *bailler*, to deliver, means, in law, a delivery of goods in trust upon a contract, expressed or implied, that the trust shall be faithfully executed on the part of the bailee or person to whom they are delivered, and the goods re-delivered as soon as the time or use for which they were bailed shall have elapsed or been performed. There is a valuable *Essay on the Law of Bailment* by Sir William Jones.

BAINBRIDGE, DR JOHN, an eminent physician and astronomer, born at Ashby de la Zouche, in Leicestershire, in 1582. He taught a grammar school for some years, and practised physic, employing his leisure hours in astronomy, which was his favourite study; but at length, removing to London, he was admitted a fellow of

the college of physicians, and raised his character by his description of the comet in 1618. The next year Sir Henry Savile appointed Bainbridge his first professor of astronomy at Oxford; and the masters and fellows of Merton College made him first junior, and then superior, reader of Linacre's lecture. He died in 1643. His published works are, 1. *An Astronomical Description of the late Comet*, Lond. 1619. 2. *Procli Sphæra*, 1620. 3. *Canicularia; a Treatise concerning the Canicular Days*; published at Oxford in 1648. Several of his writings have never been published; but the manuscripts are preserved in the library of Trinity College, Dublin.

BAIREUTH, a city, the capital of the circle of the Upper Maine, in the kingdom of Bavaria, as well as of the magistracy of the same name. It is situated on a branch of the river Maine, in a pleasant valley, and is a very ancient place, surrounded with walls, but in a state to unfit them for defence. It contains two Lutheran, one Catholic, and one Reformed church. The number of inhabitants in 1827 was 13,985. These find employment in various manufactures, especially in weaving and printing cottons, in the several modes of preparing leather, in breweries, and in making porcelain and other earthen wares. It is besides an extensive corn market. The magistracy of Baireuth extends over 121 square miles, comprehending two market-towns and 104 villages, and, besides those of the city, contains 21,200 inhabitants. Baireuth is in long. 11. 34. 10. E. lat. 49. 56. 50. N.

BAIROUT, BEIROUT, or BARUTI, anciently BERYTUS, in Greek *Βηρυτος*, a seaport of Syria, in the pashalic of Saide or Acre. A tongue of land, which presents a conspicuous headland when viewed from the north, extends itself in a plain about five or six miles from the mountains towards the sea; and on the northern edge of this plain the town is situated, on a rising ground, which contributes both to its cleanliness and salubrity. To the north the projection of the land forms a fine bay, the bottom of which is five or six miles east-south-east of the town; and there is thus a roadstead to the north-east, secured from the south-west wind, which is the prevailing one. The harbour is now choked up with sand and rubbish; and all that remains of the ancient structure is a pier, to which boats can approach sufficiently for discharging goods. All along its front are ranged fine shafts of gray granite pillars, which are used for mooring small vessels. Merchant vessels and ships of war anchor at a distance in the roadstead. The town itself is an irregular square, open towards the sea, and surrounded on the three sides which face the land with a wall built by Djezzar Pasha, defended by a few round towers of little strength, and far too feeble to resist an attack of artillery. Near the sea is an old castle, on which are six pieces of artillery; and at the common landing place is a ruined tower, built on a rock in the sea. The town is in general better built than any along the coast, and the streets are wider, being paved with large stones. The dwelling-houses are spacious, lofty, and well built; the bazars are amply furnished with provisions, as well as with the manufactures of the country and of Europe; and the magazines near the sea-shore are large and convenient. The town contains three mosques, with their courts, fountains, and minarets; and four Christian churches. Water is abundantly supplied at all seasons from several fountains, constructed by Djezzar Pasha. The suburbs are nearly as large as the town, consisting of houses interspersed with gardens, which, being planted with fruit-trees, are extremely beautiful. "The situation," says Mr Carne, "is the most beautiful of all the Syrian towns; the environs are laid out in plantations of mulberry trees, and a quantity of silk is produced and exported." Indeed, the commerce of Bairout is greater than that of

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any other port in Syria; and it is increasing. It is the maritime emporium of Damascus, and of the surrounding country. British manufactures, such as cottons, muslins, cloths, &c. with bar-iron, lead, coffee, spices, indigo, &c. are imported. The returns are made in cotton, corn, raw silk, which is the staple commodity of the country, sometimes in wine and oil, and occasionally in specie. The wall of the town is supposed to be not more than a mile in circuit; yet it is thought to contain from 6000 to 7000 inhabitants. Bairout still boasts some relics of the ancient magnificence of Berytus, that celebrated "nurse of tranquil life" (Βηρυτος βιοτοιο γαληνασιο ειθηνη), as Nonnus has called it (*Dionysiaca*, lib. xli. p. 708. ed. Falk. Antv. 1569.) Here a public school of jurisprudence, founded in the third century, acquired and long maintained a high reputation. During the reign of Justinian, the two imperial cities and Berytus were the only places within the limits of the empire where law was permitted to be publicly taught; and of the three, the Syrian school (of which Theophilus and Dorotheus, the associates of Tribonian in the compilation of the *Institutions* and the *Digest*, were *antecessores* or teachers), appears to have stood highest in general estimation. But the prosperity of Berytus was first interrupted, and finally subverted, by some of the great convulsions of nature. In the year 384, the town was greatly injured by an earthquake, and in 554 it was visited by another earthquake, which left it a heap of ruins. After this last catastrophe the professors transferred their school to Sidon, and the surviving inhabitants made an effort to raise a new city from the ruins of the old; but another calamity awaited them, and this famous seat of jurisprudence was totally consumed by fire. After a long interval, the modern town of Bairout was founded by the Derouzis near the ancient site, and was possessed by the emirs as their capital and only seaport, until they were expelled by Djezzar pasha of Acre. Long. 35. 32. E. Lat. 33. 45. N. (Buckingham's *Travels among the Arab Tribes*; Volney's *Travels in Syria and Egypt*. Carne's *Letters from the East*; Bond's *Memoir of the Rev. Pliny Flish*; Jowett's *Christian Researches in Syria and the Holy Land*, &c.)

BAITING, the act of attacking and harassing greater and stronger animals by smaller or weaker ones. In this sense we hear of the baiting of bulls or bears by mastiffs or bull-dogs.

BAJALUKA, a city, the capital of a sandschak or province of Bosnia, in Turkey in Europe. It stands on the river Berbas, and is strongly fortified with a citadel, being the frontier garrison towards Austria. It contains 2700 houses, forty mosques, and, with the suburbs, which are chiefly occupied by Greeks, 15,000 inhabitants. It is a place of considerable traffic and manufactures. Among the latter, gunpowder is the most productive. Near it are some celebrated warm medicinal springs.

BAJAROTOS, a town of the province of Aragon, in Spain, containing 2600 inhabitants.

BAJULUS, an ancient officer in the court of the Greek emperors. There were several degrees of bajuli; as, the grand bajulus, who was preceptor to the emperor; and the simple bajuli, who were sub-preceptors. The word is derived from the Latin verb *bajulare*, to carry or bear a thing on the arms or on the shoulders; and the origin of the office is thus traced by antiquaries: Children, and especially those of condition, had anciently, besides their nurse, a woman called *gerula*, as appears from several passages of Tertullian; when weaned, or ready to be weaned, they had men to carry them about and take care of them, who were called *geruli* and *bajuli*, a *gerendo et bajulando*. Hence it is that governors of princes and great lords were still denominated bajuli, and their charge or

government bajulatio, even after their pupils had grown too big to be carried about. The word passed in the same sense into Greece. Baker.

BAKER, SIR RICHARD, author of the *Chronicle of the Kings of England*, was born at Sessinghurst, in Kent, about the year 1568. After going through the usual course of academical learning at Hart Hall, in Oxford, he travelled into foreign parts; and upon his return home was created master of arts, and soon after, in 1603, received from King James I. the honour of knighthood. In 1620 he was made high sheriff of Oxfordshire: but having engaged to pay some debts of his wife's family, he was reduced to poverty, and obliged to betake himself for shelter to the Fleet prison, where he composed several books; amongst which are, *Meditations and Disquisitions on the Lord's Prayer*; *Meditations, &c. on several of the Psalms of David*; *Meditations and Prayers upon the Seven Days of the Week*; *Cato Variegatus*, or *Cato's Moral Distichs* varied, &c. Mr Granger observes, that his *Chronicle of the Kings of England* was ever more esteemed by readers of a lower class than by such as had a critical knowledge of history. In the reign of the British Solomon, the language was considered polite; and it long maintained its reputation, especially amongst country gentlemen. But the author seems to have been sometimes more studious to please than to inform, and with that view to have sacrificed even chronology itself to method. In 1658, Edward Philips, nephew to Milton, published a third edition of this work, with the addition of the reign of Charles I. It has several times been reprinted since, and by successive additions brought as far down as the reign of George I. Sir Richard also translated several works from the French and Italian; and died very poor, in the Fleet prison, on the 18th of February 1645.

BAKER, Thomas, an eminent mathematician, was born at Ilton in Somersetshire about the year 1625, and entered at Magdalen Hall, Oxford, in 1640, after which he became vicar of Bishop's-Nymmet, in Devonshire, where he wrote *The Geometrical Key, or the Gate of Equations unlocked*; published at London in 4to in 1684. He died at Bishop's Nymmet on the 5th of June 1690.

BAKER, Thomas, a very ingenious and learned antiquary, descended from a family ancient, well esteemed, and distinguished by its loyalty and affection for the crown, was born at Crook in 1656. He was educated at the free school at Durham, and thence removed to St John's College, Cambridge, in 1674. He proceeded A.B. in 1677, A.M. in 1681, was elected fellow in March 1680, ordained deacon by Bishop Compton of London in December 1685, and priest by Bishop Barlow of Lincoln the following year. Dr Watson, tutor of the college, who had been nominated, but not yet consecrated, bishop of St David's, offered to take him for his chaplain; but this he declined, probably in the prospect of a like offer from Lord Crew, bishop of Durham, which he soon after accepted. His lordship collated him to the rectory of Long-Newton in his diocese, in June 1687; and, as Dr Grey was informed by some of the bishop's family, the prelate further intended to give him that of Sedgely, worth L.600 or L.700 a year, with a golden prebend, had he not incurred his lordship's displeasure and left his family for refusing to read King James II.'s declaration for liberty of conscience. The bishop, who disgraced him for this refusal, and was excepted out of King William's pardon, took the oaths to that king, and kept his bishopric till his death. Mr Baker resigned Long-Newton on the 1st of August 1690, refusing to take the oaths; and retired to his fellowship at St John's, in which he was protected till the 20th of January 1716-17, when, with one and twenty others, he was dispossessed of it. After the passing of the Registering Act in 1723, he was

Baker. desired to register his annuity of L.40, which the last act required before it was amended and explained. Though this annuity, left him by his father for his fortune, with L.20 per annum out of his collieries by his elder brother, from the day of his death in August 1699, and during the remaining part of the lease, which expired at Whitsuntide 1722, was now his whole subsistence, he could not be prevailed on to secure himself against the act. He retained a lively resentment of his deprivations; and wrote himself in all his books, as well as in those which he gave to the college library, *socius ejectus*, and in some *rector ejectus*. He continued to reside in the college as commoner-master till his death, which happened on the 2d of July 1740, in consequence of a paralytic stroke. In the afternoon of the 29th June, being alone in his chamber, he was struck with a slight apoplectic fit; but this abating a little, he recovered his senses, and knew all those about him, who were his nephew Burton, and Drs Bedford and Heberden. He seemed perfectly satisfied and resigned; and when Dr Bedford desired him to take some medicine then ordered, he declined it, saying he would only take his usual sustenance, which his bed-maker knew the times and quantities of giving. He was thankful for the affection and care his friends showed him; but, hoping the time of his dissolution was at hand, he would by no means endeavour to retard it. His disorder increased, and the third day after he was seized with the disorder he died. Having been appointed one of the executors of his elder brother's will, by which a large sum was bequeathed to pious uses, he prevailed on the other two executors, who were his younger brother Francis and the Hon. Charles Montagu, to lay out L.1310 of the money upon an estate to be settled upon St John's College for six exhibitioners. He likewise gave to the college L.100 for the consideration of L.6 a year, then only legal interest, during his life; and to the library several choice books, both printed and in manuscript, with medals and coins; besides what he left to it by his will, which were "all such books, printed and manuscript, as he had, and were wanting there." All that Mr Baker printed was, 1st, *Reflections on Learning*, showing the insufficiency thereof in its several particulars, in order to evince the usefulness and necessity of Revelation, Lond. 1709-10, which went through many editions; and, 2d, The preface to Bishop Fisher's Funeral Sermon for Margaret countess of Richmond and Derby, 1708; both without his name. The latter piece is a sufficient specimen of the editor's skill in antiquities to make us regret that he did not live to publish his *History of St John's College*, from the foundation of old St John's House to the present time; with some occasional and incidental accounts of the affairs of the university, and of such private colleges as held communication or intercourse with the old house or college; collected principally from manuscripts, and carried on through a succession of masters to the end of Bishop Gunning's mastership, 1670. His manuscript collections relative to the history and antiquities of the university of Cambridge, amounting to forty-nine volumes in folio and three in quarto, are divided between the British Museum and the public library at Cambridge; the former possesses twenty-three volumes, the latter sixteen in folio and three in quarto. Dr Knight styles him "the greatest master of the antiquities of this our university;" and Hearne says, "Optandum est ut sua quoque collectanea de antiquitatibus Cantabrigiensibus juris faciat publici Cl. Bakerus, quippe qui eruditione summa judicioque acri et subacto polleat." Mr Baker intended something like an *Athenæ Cantabrigienses*, on the plan of the *Athenæ Oxonienses*.

BAKER, Henry, an ingenious and diligent naturalist, was born in Fleet-street, London, either near the end of the

seventeenth, or very early in the beginning of the eighteenth century. His father's profession is not known, but his mother was in her time a midwife of great practice. He was brought up under an eminent bookseller, who preceded the elder Dodsley, to the business of a bookseller; in which, however, he appears not to have engaged at all after his apprenticeship, or, if he did, it was soon relinquished by him; for although it was in his power to have drawn away all his master's best customers, he would not set up against him. Mr Baker being of a philosophical turn of mind, and having diligently attended to the methods which might be practicable and useful in the cure of stammering, especially in teaching deaf and dumb persons to speak, made this the employment of his life. In the prosecution of so valuable and difficult an undertaking he was very successful, and several of his pupils have borne testimony to the ability and good effect of his instructions. He married Sophia, youngest daughter of the famous Daniel Defoe, who brought him two sons, both of whom he survived. On the 29th of January 1740 Mr Baker was elected a fellow of the Society of Antiquaries, and on the 12th of March following, the same honour was conferred upon him by the Royal Society. In 1744 Sir Godfrey Copley's gold medal was bestowed upon him, for having, by his microscopical experiments on the crystallizations and configuration of saline particles, produced the most extraordinary discovery during that year. Having led a very useful and honourable life, he died at his apartments in the Strand on the 25th of November 1774, being then above seventy years of age. His wife had been dead some time before; and he only left one grandson, William Baker, who was born the 17th of February 1763, and to whom, on his living to the age of twenty-one, he bequeathed the bulk of his fortune, which he had acquired by his profession of teaching deaf and dumb persons to speak. His furniture, printed books (but not manuscripts), curiosities, and collections of every sort, he directed to be sold, which was accordingly done. His fine collection of native and foreign fossils, petrifications, shells, corals, vegetables, ores, &c. with some antiquities, and other curiosities, were sold by auction the 13th of March 1775 and the nine following days. He was buried, as he desired, in an unexpensive manner, in the church-yard of St Mary-le-strand; within which church, on the south wall, he ordered a small tablet to be erected to his memory. An inscription for it, he said, would probably be found among his papers; if not, he hoped some learned friend would write one agreeable to truth. This friendly office, however, remains as yet to be performed. Mr Baker was a constant and useful attendant at the meetings of the Royal and Antiquarian Societies, and in both was frequently chosen one of the council. He was peculiarly attentive to all new improvements in natural science, and very solicitous for the prosecution of them. Several of his communications are printed in the *Philosophical Transactions*; and besides the papers written by himself, he was the means, by his extensive correspondence, of conveying to the society the intelligence and observations of other inquisitive and philosophical men, both at home and abroad. The Society for the Encouragement of Arts, Manufactures, and Commerce, is under singular obligations to this worthy naturalist. As he was one of the earliest members of the society, so he contributed in no small degree to its rise and establishment. At its first institution he officiated for some time gratis as secretary. He was many years chairman of the committee of accounts, and he took an active part in the general deliberations of the society. He drew up a short account of the original of this society, and of the concern he himself had in forming it; which was read before the society of antiquaries, and would be a pleasing present to

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the public. Mr Baker was a poetical writer in the early part of his life. His *Invocation of Health* got abroad without his knowledge; but was reprinted by himself in his *Original Poems, serious and humorous*, 8vo, 1725 and 1726. Among these poems are some tales as witty and as loose as Prior's. He was the author likewise of *The Universe*, a poem intended to restrain the pride of man; which has been several times reprinted. His account of the water polype, which was originally published in the *Philosophical Transactions*, was afterwards enlarged into a separate treatise, and has gone through several editions. But his principal publications are, *The Microscope made Easy*, and *Employment for the Microscope*. The first of these, which was originally published in 1742 or 1743, has gone through six editions. The second edition of the other, which, to say the least of it, is equally pleasing and instructive, appeared in 1764. These treatises, especially the latter, contain the most curious and important of the observations and experiments which Mr Baker either laid before the Royal Society or published separately. It has been said of Mr Baker, that "he was a philosopher in little things." But if it was intended by this language to lessen his reputation, there is no propriety in the stricture. He was an intelligent, upright, and benevolent man, much respected by those who knew him best; his friends were the friends of science and virtue; and it will always be remembered by his contemporaries, that no one was more ready than him to assist those of whom he had acquaintance, in their various researches and endeavours for the advancement of knowledge and the benefit of society.

BAKER, *David Erskine*, son of the former, was a young man of genius and learning. Having been adopted by an uncle, who was a silk-throwster in Spitalfields, young Baker succeeded him in the business, but wanted the prudence and attention which are necessary to secure prosperity in trade. Like his father, he was both a philosopher and a poet, and wrote several occasional poems in the periodical collections, some of which were much admired at the time; but so violent was his turn for dramatic performance, that he repeatedly engaged with the lowest strolling companies, in spite of every effort of his father to reclaim him. The public were indebted to him for *The Companion to the Play-house*, in two volumes, 1764, 12mo; a work which, though imperfect, had considerable merit, and showed that he possessed a very extensive knowledge of our dramatic authors, and which has since, under the title of "*Biographia Dramatica*," been considerably improved.

BAKER, a person whose occupation or business it is to bake bread. The learned are in great doubt about the time when baking first became a particular profession, and bakers were introduced. It is, however, generally agreed that they had their rise in the East, and passed from Greece to Italy after the war with Pyrrhus, about the year of Rome 583. Till that time every housewife was her own baker; for the word *pistor*, which we find in

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Roman authors before this period, signified, as Varro justly observes, a person who ground or pounded the grain in a mill or mortar to prepare it for baking. According to Athenæus, the Cappadocians were the most approved bakers; after them the Lydians; and then the Phœnicians. To the foreign bakers brought into Rome were added a number of freedmen, who were incorporated into a body, or, as they termed it, a college; from which neither they nor their children were ever allowed to withdraw. They held their effects in common, and could not dispose of any part of them. Every bakehouse had a patronus intrusted with the superintendence of it; and these patroni again elected one of their number every year, who had superintendence over all the rest, and the care of the college. Out of the body of the bakers one was every now and then admitted among the senators; and to preserve honour and honesty in the college, they were expressly prohibited all alliance with comedians and gladiators. Every one had his own shop or bakehouse, and they were distributed into fourteen regions or wards of the city. They were excused from guardianships and other offices which might divert them from their employment. By British statutes bakers are declared not to be handicraftsmen. No man for using the mysteries or sciences of baking, brewing, surgery, or writing, shall be interpreted a handicraftsman. The bakers were a brotherhood in England before the year 1155, in the reign of King Henry II., although the white bakers were not incorporated till 1407, by King Edward III., and the brown bakers not till 1621, in King James I.'s time. The French had anciently a great baker, *grand panetier de France*, who had the superintendence of all the bakers of Paris.

BAKEWELL, ROBERT, a distinguished agriculturist and improver of live stock, was born at Dishley, in Leicestershire, in 1725 or 1726, and he died there in October 1795. Though all the different kinds of domestic animals were objects of his experiments and ameliorations, his attention was more particularly devoted to the improvement of the race of sheep known by the name of the Dishley or New Leicestershire breed; and so successful was he in this line, that some of his rams were let for the season at the extraordinary sum of four hundred guineas. His life presents no incidents or claims to notice, other than what arise from the improvements alluded to; but these were such as to secure him a high rank among the benefactors of British husbandry.

BAKEWELL, a market-town in the county of Derby, in the High Peak on the river Wye, 152 miles from London. The market is held on Saturday. It is remarkable for excellent trout-fishing, and for a chalybeate spring frequented by invalids. The fine seat of the Duke of Devonshire, at Chatsworth, is about six miles from the town; and Haddon Hall, the ancient family residence of the Dukes of Rutland, is in the vicinity. The population in 1801 amounted to 1412; in 1811, to 1483; and in 1821, to 1782.

BAKING

Is the art of making *bread*, meaning thereby *loaf-bread*, which is white, soft, full of cavities, has an agreeable taste, and is easily digested.

History of
the art.

1. Like most of the arts of primary importance, its origin precedes the period of history, and is involved in the obscurity of the early ages of the world. There is no evidence from Scripture that Abraham was acquainted with the method of making loaf-bread. Cakes and unleavened bread are repeatedly mentioned as made by him,

but no notice is taken of loaf-bread. We are certain that it was known in the time of Moses, as in the Jewish law there is a prohibition against making use of it during the celebration of the passover. (Exodus, chap. xii. verse 15.) Egypt, both from the nature of the country and the early period of its civilization, seems very likely to have been the place where this art was first practised. The Chaldeans, however, put in a claim. They were civilized nearly as early as the Egyptians, and they were cele-

Baking. brated among the ancients for the excellence of their bread. The Greeks assure us that they were taught the art of making bread by the god Pan. This lively and superstitious people ascribed almost all the important arts of common life to their gods; or rather, perhaps, their gratitude induced them to deify the authors of these most useful inventions. Bakers were unknown in Rome till the year of the city 580, or about 200 years before the commencement of the Christian era. They settled in that city during the war with Perseus, King of Macedon. (Plinii *Hist. Nat.* xviii. 11.) It was then that the Romans became acquainted with the refinements of the Greeks, and that their capital became crowded with adventurers of all kinds, with artists and philosophers, from the prolific soil of Achaia. Before this period the Romans were often distinguished or reproached by the appellation of the *pulse-eating nation*.

Since the introduction of bakers into Rome, the art of making bread has always been practised in the south of Europe. But it made its way into the north very slowly; and even at present, in the northern countries of Europe and Asia, loaf-bread is seldom used except by the higher classes of inhabitants. In Sweden, for example, you see rolls frequently in the towns, but never loaves. Göttenburg is a town containing about 23,000 inhabitants. In the year 1812 it was crowded with merchants from all parts of Europe, being the great connecting link between Britain and the Continent. Towards the end of that year the captain of an English packet ordered a Göttenburg baker to bake for him a quantity of bread, amounting to L.1 sterling in value. The baker was confounded at so great an order, and refused to comply till the captain gave him security that he would carry off and pay for the loaves, declaring that he could never dispose of so great a quantity of bread in Göttenburg if it were left upon his hand. In the country part of Sweden you meet with nothing but rye-cakes, as hard nearly as flint, and which are only baked twice a year. About thirty years ago loaf-bread was almost as rare in the country places and villages of Scotland, *barley bannocks* and *oaten cakes* constituting the universal substitutes among almost all ranks. But the case is wonderfully altered at present. At that time no wheat was raised in the fertile valley of Strathearn; and the village of Crieff, the largest in that valley, with a population of nearly 3000 persons, contained only two bakers, who could scarcely find employment. At present it contains five or six, and each has a brisk trade.

In many parts of England it is the custom for private families to bake their own bread. This is particularly the case in Kent, and in some parts of Lancashire. In the year 1804 the town of Manchester, with a population of 90,000 persons, did not contain a single public baker. We do not know whether or not it contains any at present.

Different kinds of wheat flour.

2. The only substance adapted for making loaf-bread is the flour of wheat, a grassy plant, distinguished among botanists by the name of *triticum*. This plant is cultivated perhaps over a greater extent of the globe than any other, and, like man, it seems to adapt itself to almost every climate. We have seen excellent crops of it raised in north latitude 60°. It is cultivated in the East Indies, considerably within the limits of the torrid zone; and, in the north of Hindostan, it constitutes a chief article in the food of the inhabitants. The original *habitat* of this plant is unknown. We know, however, that it improves considerably in its quality as we advance south. The wheat of Essex and Kent brings a much higher price than the wheat raised in East Lothian and Berwickshire. French wheat is superior to that of England. The Italians have the superiority over the French in their wheaten crops, and perhaps the best wheat of all is raised in Barbary

and Egypt. Mr Bruce found wheat growing wild in Abyssinia; and, in his opinion, that kingdom is the native country of the plant. It would seem to be originally an African plant, since it thrives best in Barbary and Egypt; and perhaps the mountains of Abyssinia, though within the torrid zone, may not differ much in point of climate from the more northern plains of Egypt. In India the plant seems to have deteriorated. It is always dwarfish, and the crop, we have been told, is less abundant than in more northern climates.

3. The culture of the different varieties of wheat, as practised in this country, and the method of grinding and fitting the flour for the baker, being foreign to the present subject, we cannot with propriety touch upon them. It may be sufficient to say, that originally in England the baker was his own manufacturer. He purchased his own wheat, and got it ground as he wanted it. At that period the miller separated the wheat into three portions; namely, flour, pollard, and bran. The bran was the outside of the grain. It was not used as food at all, or only given to horses. The pollard was the portion of the grain next the husk; it was coarser and darker coloured than the flour, which constituted the interior or central portion of the grain. This flour, at an average, amounted to three fourths of the wheat ground. But, by insensible degrees, the manufacture of bread became separated into two distinct employments; that of the mealman, who ground the wheat and sold the flour, and that of the baker, who converted it into bread. The mealman made different kinds of flour, some extremely fine and white, while others were very coarse and unpalatable. This white flour, when made into bread, was so pleasing to the eye and the taste, that it gradually got into general use, and the people refused to purchase the bread made of the whole of the flour. At present, in the mills in the neighbourhood of London, wheat is divided into no fewer than seven distinct kinds of flour. The following are the average proportions of these obtained from a quarter of wheat:—

Fine flour.....	5 bushels	3 pecks.
Seconds.....	0	2
Fine middlings.....	0	1
Coarse middlings.....	0	0.5
Bran.....	3	0
Twentypenny.....	3	0
Pollard.....	2	0
	14	2.5

wheaten } Flour and
 } Household

Thus we see that wheat almost doubles in bulk by being ground into flour.

During the bolting of the wheat there is a fine white gritty substance, called *sharps*, obtained. It constitutes the centre and finest part of the grain of wheat. This is partly sold to the biscuit-makers, and is employed in baking the finest kind of sea-biscuit. It is partly ground again, and constitutes the finest and most valuable kind of flour.

4. The bakers in Great Britain at present are restricted by act of parliament to bake only three kinds of bread, namely, *wheaten*, *standard wheaten*, and *household*. The first must be marked with a W, the second with S W, and the third with H; and the baker who neglects to mark them in this manner is liable to a penalty. The wheaten loaf is made of the finest flour, the standard wheaten of the whole flour mixed together, and the household of the coarser flour. The loaves baked are usually peck loaves, half-peck, and quartern loaves; the weights of which, provided they be weighed within forty-eight hours of the time of baking, must be as follows:—

Different kinds of bread.

Baking.

	lbs.	oz.	dr.	Avoirdupois.
Peck loaf.....	17	6	0	
Half-peck.....	8	11	0	
Quartern.....	4	5	8	

Before these loaves are put into the oven they weigh,

	lbs.	oz.
Peck loaf.....	19	12
Half-peck.....	9	14
Quartern.....	4	15

From this it appears that the average loss of the quartern loaf in weight by baking is $9\frac{1}{2}$ ounces, or not quite so much as one seventh of the whole. From the experiments of Tillet and the other French commissioners who were appointed to examine the subject in 1783 (in consequence of an opinion prevailing in Paris that the bakers did not give the full weight, while these tradesmen declared that they put the proper quantity of flour in the loaves), it appears that the French loaf loses a considerably greater weight in the oven. A loaf which, when put into the oven, weighed 4.625 lbs., when taken out of the oven weighed at an average only 3.813 lbs., or 0.812 lb. less than at first. This amounts to somewhat more than one sixth, or very nearly to $\frac{1}{6}$ ths of the whole. This greater loss is chiefly owing to the difference between the shape of the English and French loaf. The English has nearly a cubic form, while the French loaf is very long and slender. For it is obvious that the loaf which presents the greatest surface must lose most weight in the oven.

The French commissioners, however, found that this loss of weight was by no means uniform, even with respect to those loaves which were in the oven at the same time, of the same shape, in the same place, and which were put in and taken out at the same instant. The greatest difference in these circumstances amounted to 0.2889 or $\frac{7}{5}$ parts in the hundred, which is about $\frac{1}{13}$ th part of the whole. According to this rate, we may suppose that an English quartern loaf, when taken out of the oven, may vary in weight $\frac{1}{13}$ th part, which amounts to rather more than $4\frac{1}{2}$ ounces. So that the law which subjects the baker to a penalty if his bread weighs one ounce less than it ought to do, seems too severe, and must have a tendency to injure the goodness of the bread, by making the baker more solicitous about the weight than the quality of his loaf. To this we ascribe in part the badness of the London bread in general, compared with the bread in other places, particularly in Edinburgh, where it is remarkably good. But there are other causes for this deterioration of the London bread, which we believe to be of recent date. These we shall notice hereafter.

Number of loaves in a sack. 5. A sack of flour weighing 280 lbs. and containing five bushels, is supposed capable of being baked into 80 loaves in the acts of Parliament regulating the assize upon bread. According to this estimate, one fifth of the loaf consists of water and salt, the remaining four fifths of flour. But the fact is, that the number of quartern loaves which can be made from a sack of flour depends entirely on the goodness of that article. Good flour requires more water than bad flour, and old flour more than new flour. Sometimes 82, 83, or even 86 loaves, may be made out of a sack, sometimes scarcely 80.

Process of baking. 6. Let us now proceed to give a short description of the mode of baking as practised in Great Britain.

The bakehouse ought to be a large room. On one side should be erected a dresser with suitable shelves above

it; on another side a kneading-trough, about seven feet long, three feet high, two feet and a half broad at top, and nineteen inches at bottom, with a sluice-board to pen the dough up at one end, and a lid to shut down like that of a box. On a third side should be a copper capable of holding three or four pailfuls of water, with a fire-place to warm the liquid. The oven of course occupies the fourth side. It is a square apartment, about three or four feet high, with an arched circular roof and a brick or stone floor, and furnished with a door which may be shut close. It is the general custom to heat the oven with wood, either faggots or brushwood; but it would be much more economical and cleanly to employ pit-coal for that purpose. The requisite fire-place should be erected at one side of the oven, and the heat may be easily communicated by making the flue wind round the oven. This fire may also be employed to heat the copper and the water in it, which would save an additional fire, or spare the baker the disagreeable necessity of heating the copper in the oven itself, which is pretty generally practised in London. We are persuaded that an oven constructed upon this principle would save the baker a considerable annual expense, which for many years past has been continually increasing. Indeed it is obvious that the price of wood must keep pace with the augmentation of the population and wealth of the country.

The temperature to which the oven must be raised to fit it for baking bread is 450°. (*Encyclop. Method. des Arts et des Métiers*, i. 275.) The bakers do not employ a thermometer; but they reckon the oven sufficiently heated when flour thrown on the floor of it becomes very soon black without taking fire.

Let us suppose that a baker is going to convert a sack of flour into loaves. He pours the flour into the kneading-trough, and then sifts it through a fine wire sieve, which makes it lie very light, and serves to separate any impurities with which the flour may be mixed. An ounce of alum¹ is then dissolved over the fire in a tin pot, and the solution poured into a large tub, called by bakers *the seasoning tub*. Four pounds and a half of salt are likewise put into the tub, and a pailful of hot water. When this mixture has cooled down to the temperature of 84°, three English pints of yeast are added; the whole is well mixed together, strained through the seasoning sieve, emptied into a hole in the floor, and mixed up with the requisite portion of it to the consistence of a thick batter. Some dry flour is then sprinkled over the top, and it is covered up with cloths. This operation is called in London *setting quarter-sponge*.

In this situation it is left about three hours. It gradually swells and breaks through the dry flour scattered on its surface. An additional pailful of warm water is now added, and the dough is made up into a paste as before; then the whole is covered up. This is called *setting half-sponge*. In this situation it is left about five hours.

Three pailfuls of warm water are now added; the whole is intimately blended and kneaded upwards of an hour. The dough is then cut out in pieces with a knife, thrown over the sluice-board, and penned to one side of the trough. Some dry flour is sprinkled over it, and it is left in this state for four hours. It is then kneaded again for half an hour. The dough is now cut into pieces, and weighed in order to furnish the requisite quantity for each loaf; four pounds fifteen ounces being allowed for every quartern loaf. The method of moulding the dough

¹ In London, where the goodness of bread is estimated entirely by its whiteness, it is usual with those bakers who employ flour of an inferior quality to add as much alum as common salt to the dough; or, in other words, the quantity of salt added is diminished one half, and the deficiency supplied by an equal weight of alum. This improves the look of the bread very much, rendering it much whiter and firmer.

Baking. into a loaf can scarcely be described, and can only be learned by ocular inspection. The loaves are left in the oven about two hours and a half. When taken out, they are carefully covered up, to prevent as much as possible the loss of weight.

The above description applies only to the mode of baking as practised in London. No doubt, slight differences exist in different countries. The French loaf, which is baked in a pan, requires obviously a different process from the English loaf, and it is kept a longer time in the oven.

Alum is not added by all bakers. The writer of this article has been assured by several bakers of respectability, both in Edinburgh and Glasgow, on whose testimony he relies, and who made excellent bread, that they never employed any alum. The reason for adding it, given by the London bakers, is, that it renders the bread whiter, and enables them to separate readily the loaves from each other. This addition has been alleged by medical men, and is considered by the community at large, as injurious to the health, by occasioning constipation; but if we consider the small quantity of this salt added by the baker, not quite $5\frac{1}{2}$ grains to a quartern loaf, we will not readily admit these allegations. Suppose an individual to eat the seventh part of a quartern loaf a day, he would only swallow eight tenths of a grain of alum, or in reality not quite so much as half a grain; for one half of this salt consists of water. It seems absurd to suppose that half a grain of alum swallowed at different times during the course of a day should occasion constipation.

Use of
yeast in
baking.

7. The addition of the yeast of beer to make the dough swell is an improvement of the original practice. *Leaven* was used by the ancients for this purpose. Hence we read in the Old Testament of *unleavened bread*, as distinguished from *loaf-bread*. The method of baking by means of leaven is this: A quantity of flour is made up into dough with water; and this dough being set in a warm place, is left for about thirty-six hours. During that period it swells considerably, and becomes of a thinner consistency; in short, it undergoes a species of fermentation. It has now acquired a peculiar smell and a disagreeable sour taste, and is the substance known by the name of *leaven*. If this substance be mixed with a quantity of fresh dough, it occasions the whole to undergo a speedy fermentation, and to swell precisely in the same manner as dough mixed with yeast. Bread skilfully baked in this manner is not inferior to yeast bread; but when unskilfully managed, it has a sour taste, and contains a quantity of acetic acid. According to the experiments of Mr Edlin, a pound of flour, when converted into leaven, contains as much acetic acid as requires 40 grains of carbonate of potash to neutralize it. If by carbonate he means, as is probable, *bicarbonate* of potash, 40 grains of it contain 21 grains of potash, which require for saturation $22\frac{1}{2}$ grains of acetic acid.

Pliny informs us that yeast in his time was employed in Spain and Gaul as a *ferment* of bread. *Galliae et Hispaniae frumento in potum resoluto, quibus diximus generibus, spuma ita concreta pro fermento utuntur. Qua de causa levior illis quam cæteris panis est.* (*Hist. Nat.* lib. xviii. c. 7.) From this passage we see that the Romans employed leaven to raise their bread, but that they were sensible of the superiority of yeast. Leaven, however, made its way both into France and Spain, and was universally employed in the manufacture of bread till towards the end of the seventeenth century, when the bakers of Paris began to import yeast from Flanders, and to employ it pretty generally as a substitute for leaven. We have here a striking instance of the blindness and obstinacy of the learned and the powerful, and the readiness with which they are disposed to arm themselves against

all alterations and improvements. The bread by this substitution was manifestly improved both in appearance and in flavour. This variation excited attention; the cause was discovered; the faculty of medicine in Paris declared it prejudicial to the health; the French government interfered, and the bakers were prohibited, under a severe penalty, from employing yeast in the manufacture of bread.

But it is in vain for governments, colleges, and universities, to oppose themselves to those improvements which take place in the arts and manufactures essential to civilized society. The ingenuity and perseverance of self-interest is proof against prohibitions, and contrives to elude the vigilance of the most active government. The laws of Queen Elizabeth, however tyrannical and absurd, did not prevent the introduction of indigo as a dye-stuff into England. Neither did the authority of Louis the Fourteenth, nor the decision of the physicians, deter the Parisian bakers from persisting in their improved mode of making bread. The yeast in Flanders was put into sacks; the moisture was allowed to drop out; and in this comparatively dry state it was carried to the capital of France.

The superiority of yeast bread became gradually visible to all; the decisions of the medical faculty were forgotten; and the prohibition laws were allowed tacitly to sink into oblivion. The new mode of baking by degrees extended itself to other countries, and is now, we believe, practised everywhere. In warm climates, where the yeast of beer cannot be had, other substitutes are employed, which answer the same purpose. In the East Indies, bread is raised by means of the liquor called *toddy*, which flows out of the cocoa-nut tree when its branches are cut, and which ferments so rapidly, that in two or three hours it becomes an intoxicating liquor. In the West Indies *dunder* is employed for the same purpose. This is the liquid which remains in the still after the rum is distilled off, and is therefore analogous to what our distillers call *spent wash*. It no doubt consists of a solution of unaltered sugar, prevented from fermenting by the alcohol which the liquid contained before distillation, and mixed, doubtless, with a quantity of yeast. In that warm climate it undergoes a very speedy fermentation, and on that account answers all the purposes of yeast in the baking of bread. In this country it is no uncommon thing to convert the spent wash into small beer, which the workmen drink with avidity; but it only undergoes this change when fermented in the usual way with yeast.

8. The appearance of wheat flour is too familiar to every person to require any description here. The ancients knew that it consisted chiefly of a substance called *wheat starch*, which, as Pliny informs us, was first separated from wheat by the inhabitants of the island of Chio; and in his time the starch of Chio was considered as the best and lightest, because it was made from wheat which was not ground. (*Hist. Nat.* xviii. 7.) This is the mode still followed by the manufacturers of starch, and is no doubt the reason why the other constituents of wheat were so long in being discovered. About the year 1728 Beccaria, an Italian philosopher, discovered another constituent of wheat, to which the name of *gluten* has been given. His method of obtaining it was this: He took a quantity of flour, and formed it into dough with water; this dough he kneaded continually between his fingers, while a small stream of water dropt upon it. He continued the kneading as long as the water ran off milky. By this process, the whole of the starch was washed away, and there remained in his hand a gray-coloured, elastic, and very adhesive substance, which was the gluten. (*Collect. Académ.* partie étrang. x. 1.) No other grain besides wheat contains gluten in any considerable quantity. Traces of it may be discovered in barley. But the gluten of

Baking.

barley cannot be separated by washing. It is obtained by solution in water; for gluten is soluble in a small proportion in cold water. But when that liquid is heated to 120° or 130° the gluten coagulates, and falls down in gray-coloured flocks. By this method gluten may likewise be discovered in the leaves of many trees.

The water employed to wash out the starch soon deposits that substance in the form of a white powder. If this water be now filtered, evaporated to a small quantity, filtered again to separate the coagulated gluten, clarified with white of egg, and then evaporated to the consistence of a syrup, it deposits, according to Mr Edlin, crystals of sugar in four-sided prisms, with dihedral summits. (Edlin *On Bread Making*, p. 49.) If this experiment be correct, wheat contains a portion of common sugar. But we have great doubts respecting it. We scarcely believe it possible to obtain in regular crystals the very small quantity of sugar that must be contained in a pound of wheat by the process described by Mr Edlin, for he merely set the syrup aside to crystallize in a cool place. Common sugar thus treated would concrete into a hard mass, but would not crystallize. We believe that wheat flour contains a portion of saccharine matter, but it is a species different from common sugar. We have never, indeed, made any experiments on the sugar of wheat, but we have made a great many on the saccharine matter of barley, which we found similar in its properties to the sugar into which starch is converted by being long boiled in very dilute sulphuric acid. There is every reason to believe that the sugar in wheat is similar to that in barley. Now the sugar in barley crystallizes in spheres similar to candied honey.

9. Starch, the first, the most important, and by far the most abundant constituent of wheat flour, is a white, crisp, crystalline-like substance, insoluble in cold water, but forming with hot water a thick paste, which has the property of gluing bodies together. If it be roasted on the fire till it assume a brown colour, it becomes soluble in water, and acquires the properties of gum. If it be boiled for forty-eight hours in water holding one hundredth part of its weight of sulphuric acid in solution, it is dissolved and converted into a species of sugar. This sugar is heavier than the starch from which it was formed; the sulphuric acid remains unaltered; and no gaseous body is either absorbed or emitted. Hence it has been concluded that this sugar is merely a combination of starch and water, and that the acid acts only by promoting the solution of the starch, without which it is incapable of uniting with water. Starch is one of the most nourishing articles of food, and is undoubtedly the portion of the wheat flour that renders bread so nutritive.

10. The gluten, the second constituent of wheat flour, is but small in quantity when compared with the starch. It is a gray substance, exceedingly elastic and adhesive. It is not sensibly soluble in water after it has been collected into an adhesive mass, nor does it dissolve in alcohol or ether. When dried, it becomes brown and semitransparent; and when thrown on hot coals, it emits a smell similar to that of burning horn. If it be put into a vessel, moist, and set in a damp place, it undergoes a species of fermentation. Bubbles of gas separate from it. After some days it becomes of a much thinner consistence, and may then be employed to agglutinate substances together. In about ten days or a fortnight it acquires exactly the smell and taste of cheese, which it resembles in every thing but the colour, which is too dark. This caseous fermentation, if the expression may be permitted, distinguishes gluten from all other vegetable bodies with which we are acquainted. It is to the gluten that wheat flour owes the property of being converted into loaf-bread. All

other grains are unfit for that purpose; but they become fit as soon as we add to them a sufficient quantity of gluten, or mix them with wheat flour. In this way barley, potatoes, and even turnips, may be made into very good bread.

11. The sugar is by far the smallest in proportion, of all the constituents of wheat flour. If it be starch sugar, as we believe it to be, it possesses the following properties: It does not crystallize in prisms like common sugar, but assumes the form of spheres like honey. It is not so hard as common sugar, neither is it so soluble in water. Its sweetening power, according to Kirchoff, is to that of common sugar as 1 to 2½. But the most distinguishing property is, that, when dissolved in water, it ferments of itself, without the addition of any yeast; whereas common sugar does not undergo that process unless yeast be mixed with its aqueous solution. Hence the reason why the dough of wheat flour ferments, and is converted into leaven. This fermentation does not take place if the saccharine matter be washed out of it by water, as Mr Edlin ascertained by direct experiment. The fermentation of wheat flour is at first confined to the saccharine matter. It first undergoes the vinous fermentation: here the process, if possible, ought to be stopped. But as this is usually not possible, the acetous fermentation commences, and vinegar is formed. Probably at last the starch itself is acted on, and occasions the bad taste of ill-baked leavened bread, though this is doubtful.

12. As to the proportions of these three constituents, they differ so much in different kinds of wheat flour, that nothing precise on the subject can be determined. The greater the proportion of gluten, the better in all cases is the flour. When the wheat has not fully ripened, or when it has been exposed to rain while lying on the field, the gluten cannot easily be separated from the starch by the process above described; nor does it form an elastic, adhesive mass, but a friable substance, distantly resembling the fibrous matter of potatoes. Hence the goodness of the flour may be determined by the state of the gluten. The writer of this article has repeatedly applied this test to London flour, but he has been always unlucky enough to find it decidedly bad. From the flour furnished by two or three different bakers in different parts of the town, he either was unable to obtain any gluten, or it wanted the adhesiveness which characterizes the gluten of good wheat. No doubt there must be abundance of excellent flour in London, but we believe (and our opinion is founded on the bread, which in general is greatly inferior in goodness to the Edinburgh bread) that a very considerable proportion of the flour used is bad. The inhabitants of London pride themselves on the goodness of their bread, but never was any set of men more mistaken. The London bread is indeed whiter, but, in other respects, worse than any we have met with in Great Britain, except the bread baked in Berwick-upon-Tweed, which is very bad, owing entirely to the unskilfulness of the bakers.

To furnish an idea of the proportions of the constituents of flour in good wheat, we shall give the result of an analysis of Mr Edlin's. He separated a pound avoirdupois of wheat into the following ingredients:

Bran.....	3 oz.	0 dr.
Starch.....	10	0
Gluten.....	0	6
Sugar.....	0	2
Loss.....	2	0
Total.....	16	0

In this case it appears that the gluten amounted to $\frac{1}{16}$ of the whole flour, the sugar was $\frac{1}{80}$ th part, the bran $\frac{3}{16}$ th, and the starch almost $\frac{2}{3}$ ds of the whole flour.

Baking.

Baking.
Modes of
preparing
yeast.

13. The yeast which is employed to ferment or raise the dough is obtained in London from the brewers of ale. In Edinburgh the greater part of the yeast used by the bakers is either prepared by these tradesmen themselves, or procured from those who manufacture yeast on purpose to supply the bakers. Various methods and various ingredients are used for this purpose; but the following method is, we believe, as good as any.

Add ten pounds of flour to two gallons of boiling water: stir it very well into a paste. Let this mixture stand for seven hours, and then add about a quart of yeast. In about six or eight hours this mixture, if kept in a warm place, will have fermented, and produced as much yeast as will bake a hundred and twenty quartern loaves.

Yeast made in this way answers the purposes of the baker much better than brewers' yeast, because it is clearer, and free from the hop mixture, which sometimes injures the yeast of the brewer. Some years ago the bakers of London, sensible of the superiority of this artificial yeast, invited a company of manufacturers from Glasgow to establish a manufactory of it in London, and promised to use no other. About L.5000, accordingly, were laid out on buildings and materials, and the manufactory was begun on a considerable scale. The ale-brewers, finding their yeast, for which they had drawn a good price, lie heavy on their hands, invited all the journeymen bakers to their cellars, gave them their full of ale, and promised to regale them in that manner every day, provided they would force their masters to take all their yeast from the ale-brewers. The journeymen accordingly declared in a body that they would work no more for their masters unless they gave up taking yeast from the new manufactory. The masters were obliged to comply; the new manufactory was stopped, and the inhabitants of London were obliged to continue to eat worse bread, because it was the interest of the ale-brewers to sell their yeast. Such is the influence of journeymen bakers in the metropolis of England.

What the substance in yeast is which induces fermentation, has not yet been determined. Beer yeast may be dried, and kept in that state for a considerable length of time; and if moistened again with water, it becomes capable of acting again as a ferment. If it be washed in alcohol, its fermenting power is destroyed. If it be kept in a moist place, it undergoes a change very similar to the caseous fermentation of gluten. But yeast and gluten are distinct substances; for gluten is incapable of producing the vinous fermentation. Sugar of starch ferments of itself when diluted with water; and the juice of grapes also ferments of its own accord, because it contains a quantity of sugar similar to the sugar of starch.

But, as far as baking is concerned, the knowledge of the peculiar substance which occasions fermentation is not material. The only useful purpose which fermentation in dough serves, is to generate a quantity of carbonic acid gas. If the dough be impregnated with this gas by any other method, fermentation is not necessary. Mr Henry of Manchester found, that if flour be kneaded into dough with water saturated with carbonic acid gas, the dough rises as well, and the bread is as light and well tasted, as when it is baked with yeast. Hence those bakers who live near Seltzer water, or any water impregnated with carbonic acid gas, may substitute that liquid for yeast without injuring the quality of their bread. The quantity of salt contained in a quartern loaf may be reckoned about an ounce avoirdupois, or 437 grains. If, instead of the ounce of salt, you dissolve in water 2 oz. 5 dr. 45 gr. of the common crystallized carbonate of soda, and mix the solution well with your dough; if you now add 7 oz. 2 dr. 22 gr. of muriatic acid, of the specific gravity of 1.121,

and knead it as rapidly as possible with the dough, it will rise immediately, fully as much, if not more, than dough mixed with yeast, and, when baked, will constitute a very light and excellent bread.

14. These examples are sufficient to explain what is Panary called the *panary* fermentation. There is, in fact, no such thing as a fermentation peculiar to bread. But wheat flour contains a portion of saccharine matter, which readily undergoes the vinous fermentation. During this fermentation, carbonic acid gas is evolved in every part of the dough. This gas is prevented from escaping by the gluten, which forms everywhere through the dough an adhesive web, through which gaseous substances cannot make their way. Hence the dough swells in every direction, the particles of starch are separated from each other, and by the heat of the oven they are arrested in that position; so that the loaf, when cut, appears full of round and oblong cavities, each of which in the dough had been filled with a globule of carbonic acid gas. It is to the presence of these cavities that the bread owes its lightness, its agreeable taste, and its easy digestion. Even its colour is owing, in a great measure, to the same cause; for when loaves of wheat flour are baked without the addition of yeast, or the presence of carbonic acid, they constitute one solid, dark-coloured, disagreeable-tasted mass, which has been found not only nauseous to the palate, but likewise of difficult digestion. These disagreeable qualities are, in a great measure, obviated by converting the dough into thin cakes, and baking them rapidly on a hot iron plate over the fire. Accordingly, this is the method followed when wheat flour is converted into bread without fermentation.

Thus, then, the theory of bread-making is completely developed. Nothing can be simpler or more ingenious than the process followed by the baker. Nor ought the wonderful composition of wheat flour, which adapts it so well for the manufacture of bread, to be passed over in silence. Without the presence of the saccharine matter, the fermentation could not be produced in it, carbonic acid gas would not be evolved, and the bread would be hard, heavy, black, and difficultly digestible. Without the presence of the gluten, the carbonic acid would make its escape as soon as formed, and the advantages of the fermentation would be lost. And, finally, without the presence of the starch in such a notable proportion, the bread would neither be a palatable nor a nourishing article of food. It has been supposed, indeed, that the gluten is the substance which renders bread so nourishing. But we conceive this to be a mistake. In the first place, its quantity, when compared with that of the starch, is trifling; and, in the second place, we know from other circumstances, that starch is peculiarly fitted for being the food of animals. Nearly one half of the human race live almost wholly on rice, a grain which consists almost entirely of starch; and the small quantity of that grain which constitutes the daily food of an inhabitant of Hindostan, and which supports his life, is truly astonishing.

15. As no other grain except wheat flour contains these three constituents in the requisite proportions, it would be in vain to attempt to convert them into bread by the same process as is followed by the baker in making wheaten bread. Potatoes, for example, contain no sensible quantity of saccharine matter. It would be in vain, therefore, to expect them to ferment like wheat dough when mixed with yeast; but we have little doubt that mashed potatoes might be made into very good bread if they were kneaded with water impregnated with carbonic acid gas, or still better, if, instead of common salt, the constituents of that substance were added in the proper proportions, as they have been already given in this article. Potatoes

Baking.

fermenta-
tion.

Nutritive
qualities of
bread.

Potato
bread.

Baking. contain a very great proportion of water, and when boiled in water, they communicate a brown colour, and give the liquid a disagreeable taste and smell.

It is proper that this substance, which some have considered as of a poisonous nature, should be previously removed. Einhof has given us the following substances as the constituents which he found in potatoes:

Water.....	72.6
Starch.....	15.0
Fibrous matter.....	7.0
Albumen.....	1.4
Mucilage.....	4.0

100.0

Dr Pearson's analysis is somewhat similar, only he obtained a greater proportion of water. Einhof found both tartaric and phosphoric acid in potatoes. The fibrous matter in potatoes seems to be a peculiar modification of starch. It supplies the place of the gluten in wheat flour, and gives to the paste of potatoes considerable stiffness and adhesiveness. It is upon these properties that we found our opinion, that if the paste of potatoes were properly impregnated with carbonic acid gas, it would make a good-looking and well-tasted loaf. There is, however, the less occasion for this attempt, as potatoes, when properly boiled, constitute an agreeable substitute for bread without any further preparation. When made into bread, they are always mixed with wheat flour. A mixture of two parts flour and one potatoes makes an agreeable bread, which cannot be distinguished from wheaten bread. The starch of potatoes is remarkably beautiful, and goes farther than wheat starch. We have been assured, that what is sold in the shops under the name of Indian arrow root, is nothing else than potato starch mixed with a little gum tragacanth. It is well known what an agreeable food this preparation is capable of furnishing.

Rye bread. Rye is very much used as an article of food in northern countries. In Sweden it constitutes almost the only bread of the common people, not baked in loaves, but made up into cakes, which are usually as hard as wood. When baked into loaves, it has a brown colour and a sweetish taste, which gives it a considerable resemblance to gingerbread. Rye, according to the analysis of Einhof, is composed of the following constituents:

Albumen.....	3.27
Moist gluten.....	9.48
Mucilage.....	11.09
Starch.....	61.09
Saccharine matter.....	3.27
Husk.....	6.38
Moisture.....	5.42

100.00

The saccharine matter present in this grain is probably sufficient to cause it to undergo fermentation; but the proportion of gluten is very small, probably not amounting to 3 per cent. Accordingly, when rye flour is washed in water, the whole of the gluten is dissolved in that liquid. Hence it is obvious, that, in order to make good rye bread, it ought to be mixed with a quantity of wheat flour. This kind of bread is very much used in the counties of Northumberland and Durham, and we have no doubt that it is both palatable and nourishing. Certainly it is very superior to the rye cakes used by the peasants in Sweden.

We have been told that rice flour may be made into loaf-bread; but we have never had an opportunity of seeing these loaves, and do not know how far they resemble those of wheat flour. Rice has never been subjected to chemical analysis. We do not know, therefore, what its constituents are, though there is every reason, from

Baking. its properties, to consider it as almost entirely composed of starch.

16. Gingerbread is composed of flour, treacle, butter, common potashes, and alum. After the butter is melted, and the potashes and alum dissolved in a little warm water, these three ingredients, along with the treacle, are poured into the flour which is to form the basis of the bread. The whole is then kneaded into a stiff dough. The alum renders the bread crisper and lighter, and accelerates the period at which the dough is fit for baking; for gingerbread dough must stand over from three or four to eight or ten days before it is fit for baking. The reason of this is, that the carbonic acid gas, by means of which the bread is to be raised, exists in the potashes, which, so far as they are useful, consist of carbonate of potash. This gas is evolved by the action of an acid on the carbonate, derived chiefly from the fermentation of the treacle, and its partial conversion into acetic acid. This conversion is more or less rapid in different circumstances. Hence the uncertainty respecting the time when the dough becomes fit for being baked.

This method of making gingerbread, at present universally followed, is obviously a bad one. The length of time that the dough must lie before it becomes fit for baking is apt to injure its quality. The large quantity of potash used affects the taste of the bread, unless it be concealed by the addition of some aromatic ingredient. It would be much better, therefore, to substitute some other less injurious method. Were we, for every $7\frac{1}{2}$ parts of common salt which would be required for the bread, to add $10\frac{1}{8}$ parts of bicarbonate of soda, and then incorporate the dough with $13\frac{5}{8}$ parts by weight of the common muriatic acid of commerce, the carbonic acid gas evolved would be amply sufficient to render the bread exceedingly light, and the dough would be immediately fit for baking, while the additions thus made would be merely equivalent to the quantity of common salt used in baking loaf-bread.

Dr Colquhoun, in his *Essay on Baking*, published in the *Annals of Philosophy* (2d series), vol. xii. p. 276, has proposed the following mode, which he found by trial to make excellent gingerbread. "Take a pound of flour, a quarter of an ounce of carbonate of magnesia, and one eighth of an ounce of tartaric acid. Let the butter, treacle, and aromatics, be added in the same way as at present. The magnesia should be intimately mixed with the flour before the latter is wetted. Dissolve the tartaric acid in a small quantity of water, and pour it, together with the melted butter and treacle, into the flour. Let the whole be incorporated into a mass of dough by kneading, and then set aside the dough for an hour. If now baked, it makes a light, spongy, pleasant bread." The baker would accomplish the same object if he were to mix bicarbonate of potash with the dough, in the proportion of four parts bicarbonate to three parts tartaric acid.

17. Having now given a description of the method of Assize of baking bread, and explained the nature of the process, bread, and we might here conclude this article. But it may be of state of the some utility, if we give a short statement of the principal bread trade laws which have been enacted in Great Britain respecting in London. bread, and we endeavour to lay before the public the present state of the bread trade in London, and explain the abuses and frauds which are practised by those concerned in it in that capital. We despair of seeing these abuses rectified, but it is a great point at least to make them known.

In the period of English history between the Norman conquest and the reign of Edward the First, the price of wheat fluctuated enormously. Thus, in the 43d year of Henry the Third, it was sold for 20s. or 60s. of our money

Baking. a quarter. Multitudes of poor people were forced to live upon the bark of trees, and upon horse-flesh, and above 20,000 died in London of famine. In the same reign, as appears from the statutes, the price of wheat was as low as 1s. a quarter. These prodigious fluctuations show the little communication at that time existing between the different countries of Europe. Farming must then have been in a very low state in England. When wheat was very cheap, the farmer could not dispose of his crop, which lay rotting on his hands. When it was dear, there was such a scarcity that he could hardly procure seed for sowing his fields, or was unable to afford money to purchase it.

It was conceived that these evils would be in a great measure remedied by fixing the price of bread, which was accordingly done by a proclamation of King John. This absurd innovation being found ineffectual, it was repealed by the *statute of assize*, enacted in the 51st year of Henry the Third, A. D. 1267. By this law the price of bread was regulated by the price of wheat, and the baker was allowed 7½d. for baking a quarter of wheat, and furnishing salt and the other ingredients which are added to bread; besides the profit which accrued from the additional loaves made from a quarter of wheat beyond what the statute allows. This money allowance was gradually augmented to the baker in different reigns, according to the following statement:

	s.	d.
Edward I.....to.....	1	1
Henry VII.....	2	7
Elizabeth.....	6	10
Elizabeth.....	6	0
Anne.....	12	0
George II.....	15	6
George III.....	14	0

This last regulation took place in the year 1798. By this act, the magistrates were enjoined to set the assize from a sack of flour, instead of a quarter of wheat, and to allow the baker 11s. 8d. for his expenses. The new duty on salt, during the French revolutionary war, raised this sum to 12s., at which it continued. By the act of parliament, the baker was supposed to make 80 quartern loaves from the sack of flour; whatever greater number the sack produced was so much more profit to the baker.

Very particular laws were enacted, obliging the corn-factors to give in the quantities and prices of the flour sold, and the bakers the quantities and prices at which they bought it. Penalties were enacted to prevent false returns, to prevent adulterations and improper combinations between the bakers, or the corn-factors and bakers. The weight of the loaf was determined, and all loaves deficient in weight one ounce, or not marked with the letters W, S W, H, according to the quality of the bread, may be seized; and the baker, besides the loss of his bread, is subjected to a penalty. These laws are so numerous and so minute that it would be tedious to copy them. Nothing would be learned from them but the amount of the penalty for each offence, varying from L.50 to 1s., according to the supposed enormity of the transgression. It is the business of the magistrates in towns, and of justices of the peace in the country, to regulate the assize; and the price of bread is determined by the price of wheat, according to a table given in one of the acts. When that price varies 6s. the quarter, then the price of the loaf is varied one assize, or a halfpenny the quartern loaf. Magistrates likewise may alter the price of the loaf half an assize, or a farthing in the quartern loaf.

Whoever considers the indecent way in which oaths are administered in English courts (for it is upon the oaths of the bakers and corn-factors that the acts depend for the accuracy of the returns), and the little regard paid to

Baking. them by merchants and manufacturers, partly in consequence of this indecency, partly in consequence of their multiplicity, and partly on account of the many absurd impediments that the legislature has thrown in the way of merchants and manufacturers; whoever considers these things, will be at no loss to conclude, that all these checks, and penalties, and oaths, have entirely failed in producing the intended effects. In London, where the number of bakers is great, and the competition in consequence ought to insure the best bread at the lowest possible price, the bread-laws, by making the prices of all bakers the same, have destroyed this competition; formed the bakers into a regular company, having occasional meetings to consult their peculiar interest; and raised in them a feeling of honour, which makes them consider it unhandsome to undersell their neighbours. The price of flour is easily regulated between the bakers and the corn-factors; the consequence of which regulation is, that the quartern loaf is always 2d. dearer than in any other part of Great Britain. The reason assigned is, that the finest flour only is employed in London, and that the London bread is better than any other. The writer of this article is well aware of the contrary. The London bread is, in his opinion, nearly the worst bread in Great Britain; and the flour is greatly inferior to that which is used by the bakers in Edinburgh. He has frequently examined flour purchased from bakers in both cities, and the Edinburgh flour, except in bad years, when the crop had been injured, was uniformly superior in quality to the London flour.

The magistrates of London have at last become sensible of the truth of these facts; and that the government, by their officious interference and their minute enactments, have injured instead of improved the quality of the bread. They have, in consequence, applied to parliament, and by their influence, the assize on bread, as far as it affects London and its environs, has been taken off. But the good effects expected have not yet resulted from this judicious measure. The spirit of monopoly has been sunk so deep into the minds of the bakers by the assize laws, that some time must elapse before it can be eradicated. It is said that they have a weekly meeting, and settle the assize privately in the same manner as it was before publicly done by the lord mayor and aldermen of London. But this *esprit de corps* cannot continue very long. Where there are 1600 bakers, as in London and Westminster, it is not consistent with the nature of things to suppose that they can long continue united, so as to act only together and by concert. Self-interest will induce first one individual, and then another, to consult to his own private advantage, and to endeavour to secure an increase of business by underselling his neighbours. The bond will thus be broken asunder, and every one will be obliged to serve the community at the lowest possible rate.

It is a pity that the legislature would not see that the same liberty which has been given to the baker ought to be extended to the corn trade in general. The depreciation of money, which was the consequence of the unnatural state into which Europe was brought by the French revolution, our almost total seclusion from the Continent, and a series of bad crops for several years, raised the price of corn in this country to an enormous height. The landlords took advantage of this increase to raise the rents, while government loaded the farmer with heavy taxes. But in a state of peace, and supposing the seasons to be tolerably favourable, the prices cannot be kept up. The landed proprietors, indeed, conceived that the price of corn could be continued in this country at its unnatural height, simply by prohibiting the importation of foreign corn. It was with this view that the corn-bill was brought into parliament and carried in the year 1815 by a great majority,

Baking. notwithstanding the almost universal expression of the inhabitants of Great Britain against the measure. These legislators did not consider that the average deficiency of corn in Great Britain does not amount to a week's consumption; that though they may prevent corn from being imported into Great Britain, they cannot prevent such of the inhabitants as choose it from going to those places where corn is cheap. The corn-bill will not have the effect of keeping up the price of corn; but it will act as an encourager of emigration. Suppose the population of Great Britain to be 16,000,000, the emigration of 100,000 inhabitants would probably be sufficient to prevent the necessity of importing corn. Perhaps a smaller number would be sufficient, as those who will be obliged to emigrate are chiefly families with small fortunes, who may be supposed to consume more wheaten bread than the very lowest of the people. The hardships of the farmer cannot be alleviated in any other manner than by lowering his rent, and easing him of his oppressive taxes. The present mode of allowing the importation of foreign corn at a tax which diminishes as the price advances, till it is reduced at last to 1s. per quarter, is an improvement on the old mode, but it is still defective. Prices never can become steady till all restrictions on the trade of corn are removed.

18. About sixty years ago the dealers in corn in London carried on their business at Bear Quay; but, this situation being very inconvenient, the Corn Exchange in Mark Lane was erected by a company of proprietors, for the accommodation of the factors and dealers. Seventy-two stands were allotted on which the samples of corn are exposed to sale. Sixty-four of these stands are let out on lease to factors or dealers, and the remaining eight are appropriated to the use of the Kentish hoymen. "Although the Corn Exchange is considered as open to all who come to buy and sell, yet no person can carry on the business of a corn-factor, to any considerable extent, unless he is in possession of one of these stands. Here the factors are at liberty, either to expose all their samples at the same time, or as few of them as they think fit; so that a buyer has no means whatever of judging, from the appearance of the samples exposed on the stands, during any period of the market, what the supply is, or what quantities of corn are imported, coastwise or from abroad." (*Report of the Committee of the House of Commons respecting Corn.*)

Here the millers, mealmen, and corn-chandlers, transact their business with the corn-factor, and not with the seller. These men purchase the wheat, carry it down to Essex and other counties, convert it into flour, and bring

it back to London to supply the bakers. The profits of the baker are but small, supposing him to carry on his trade without any fraud. Let us suppose him to bake twelve sacks a week, which, from the evidence of the bakers examined before the committee of the House of Commons, seems to be a fair average. They are allowed 12s. for each sack, which amounts in the week to L.7. Let us suppose further, that every sack yields eighty-two loaves instead of eighty, so that they have a profit of two loaves on each sack. This, when the quartern loaf is at 10d., will amount to L.1 more. And let us suppose still further, that the puddings, pyes, and meat, which they bake, will defray the expense of their fuel. By this statement, their weekly income will be L.8, out of which they have to pay for salt and yeast, and likewise their journey-men's wages. Now, L.4 seems as little as can well be allowed for these purposes. According to this statement, L.208 a year seems to be the amount of an ordinary baker's income in London, supposing him not to practise any fraud.

The consequence of this small profit is, that men of capital seldom embark in the trade. The bakers in London are mostly poor men, who begin the world without any capital, and, in consequence of the great competition, are never able to deal so extensively as to acquire one. It is scarcely necessary to observe what must be the consequence of this. They are at the mercy of the mealmen, who supply them with flour as they think proper, of what quality they think proper, and at what price they think proper. Hence the high price and the badness of the London bread. The profits go all into the pockets of the mealmen, who keep the bakers in a state of comparative slavery, and oblige the inhabitants of London to eat the worst and the dearest bread in Great Britain.

Some ingenious bakers in London, in order to make up for the smallness of their profits, have hit upon the plan of mixing potatoes with their flour; and we are credibly informed that not less than 300 tons of potatoes are consumed for this purpose every week. Perhaps the quality of the bread is not much injured by this practice; for some of the bakers most in repute employ potatoes to a considerable extent, and the consumption of wheat is very materially diminished by it. But the grievance is, that the same price is taken for a potato loaf as for a loaf of the finest wheaten flour, though it must cost the baker much less.

The reader will find some account of the substitutes which have been proposed for wheat flour, in seasons of scarcity, under the article BREAD. (L.)

BAKU, or BAKU, a town, with an adjoining district of the same name, in Persia. Badku is the most spacious and convenient port in the Caspian, and stands in the peninsula of Absharon, in long. 51. 7. E. lat. 42. 22. N. It is a place of considerable trade, and is defended by a double wall and ditch, constructed during the reign of Peter the Great. The town is situated on a declivity, and is of an obtuse triangular form. It was a celebrated resort of the ancient worshippers of fire, and before the conquest of the Saracens was annually visited by thousands of pilgrims. In the adjacent district a great quantity of excellent cotton is produced, and is exported from Badku; together with fruit, opium, rice, silk, wine, rock-salt, and naphtha. Cloths, dye-stuffs, iron, linen, and silk stuffs, are imported from Astracan, from which six or eight vessels arrive yearly, and with which its principal trade is car-

ried on. In the plain to the south-east of the city, enormous quantities of naphtha are produced. It is drawn from wells, some of which yield from 1000 to 1500 pounds in a day. These wells contain inexhaustible springs of oil; and they are no sooner emptied than the oil begins to flow, and continues until it has attained its former level. It is used by the natives for lamp-oil, and emits a clear light, with much smoke and a disagreeable odour. All around the town the country is deeply impregnated with inflammable matter, both above and below the surface. About ten miles to the eastward is a fine temple of the Guebres; a remarkable spot, something less than a mile in circumference, from the centre of which a bluish flame is seen to arise. Here are some small houses; and the inhabitants, when they wish to smother the flame, cover the space inclosed with walls by a thick loam of

Balaam || **Baladan.**
 earth. When an incision is made in the floor the flame arises, and it is again suppressed when it is no longer wanted for culinary or other purposes, by closing the aperture. The whole country around Badku has at times the appearance of being enveloped in flames. It often seems as if the fire rolled down from the mountains in large masses with incredible velocity; and at night a bright blue light is observed to cover the whole western range of hills. This fire does not consume, and no warmth is felt, even though a person be in the middle of it. The jurisdiction extends over thirty-two villages. It was ceded to Russia in 1723, and was restored to Persia in 1735. It was several years under the dominion of a Persian prince, and was taken possession of by the Russians in 1801, by whom it is now retained. Long. 51. 7. E. Lat. 42. 22. N.

BALAAM, a prophet and diviner of the city of Pethor, on the Euphrates, whose practices with Balak, king of the Moabites, are recorded in the book of Numbers, chap. xxii. It is a question much debated among divines, whether Balaam was a true prophet of God, or no more than a magician or fortune-teller. The Scripture, 2 Pet. ii. 16, denominates him a prophet; and this by some has been thought decisive of the point; although it is expressly stated that he "loved the wages of unrighteousness," and was "rebuked for his iniquity" by "the dumb ass," which "forbade the madness of the prophet." As to what passed between him and his ass, when the latter was miraculously enabled to accost its master and rebuke him, commentators are divided in opinion; some doubting whether the fact really and literally happened as Moses relates it, and others thinking it an allegory only, or the mere imagination or vision of Balaam. Philo, in his *Life of Moses*, passes over this wonderful incident in silence; and Maimonides pretends that it happened to Balaam in a prophetic vision only. But St Peter (*ubi supra*) speaks of this fact as literal and certain, and so most interpreters explain it. St Austin, who understands it exactly according to the letter, finds nothing in the whole account more surprising than the stupidity of Balaam, who heard his ass speak to him, and answered it as if he had talked with a reasonable person. Le Clerc thinks that Balaam might probably have imbibed the doctrine of transmigration of souls, which was certainly very common in the East; and on this account he might probably be the less astonished at hearing a brute speak. Gregory of Nyssa seems to think that the ass did not utter any word articulately or distinctly, but that, having brayed as usual, the diviner, whose practice it had been to draw presages from the cries of beasts and singing of birds, comprehended easily the ass's meaning by its noise; Moses designing to ridicule this superstitious art of augurs and soothsayers, as if the ass had really spoken in words articulate.

BALACHNA, a circle of the Russian government of Nishegorod, containing about 90,000 inhabitants. The chief place is a city of the same name, at the junction of the river Usola with the Wolga. It contains about 4500 inhabitants, who carry on a trade in linen, and in salt produced from springs near it. Long. 43. 25. E. Lat. 56. 15. N.

BALADAN, the Scripture name for a king of Babylon, called by profane authors *Belesus* or *Belesis*, *Nabonassar* or *Nanybrus*. Baladan was at first no more than governor of Babylon; but having entered into a confederacy with Arbaces, governor of Media, and rebelled against Sardanapalus, king of Assyria, both generals marched against him with an army of 400,000 men, and were defeated in three different battles. The Bactrians, however, deserted the king, and having gone over to Baladan and Arbaces, the rebels, thus reinforced, attacked their enemy in the

night, and made themselves masters of his camp. After this misfortune, Sardanapalus retreated to Nineveh, and left the command of his army to his brother-in-law Salamenes. The conspirators attacked Salamenes, and defeated him in two great battles; after which they laid siege to Nineveh. Sardanapalus sustained the siege for three years; but the Tigris, in the third year, overflowing its banks, beat down twenty furlongs of the walls; upon which the conspirators entered the city and took possession of it, after Sardanapalus had burnt himself and all his most valuable effects upon a funeral pile erected for the purpose in his palace. Baladan was acknowledged king of Babylon, as Arbaces was of Media.

BALAGHAUT Ceded Districts. This country, which is in the south of India, comprehends an extensive tableland, supported like a terrace by the stupendous mountain wall of the Ghauts. It is a vast extent of level plains, stretching from the Krishna to the southern extremity of the Mysore, and is named Balaghaut, or "Above the Ghauts," in contradistinction to Payenghaut, or "Below the Ghauts." This tract of country, which was acquired by the British in 1800, comprehends all the territory south of the Toombuddra and Krishna rivers, which are its proper boundaries, and which, owing to its elevated surface, are the only large rivers which it possesses. The country, the greater proportion of which is under dry cultivation, produces sugar, indigo, and cotton. In 1806 a census was made out of the population, which amounted to 1,917,376. After these districts were obtained from the Nizam in 1800, they were placed under the management of Colonel Munro, and since this period they have made great advances in population and prosperity. In the course of seven years the land revenues increased from 1,006,593 to 1,517,272 pagodas; and the inhabitants, from being a horde of lawless freebooters, were reclaimed to habits of civilization and submission to the laws. In the year 1808 the total amount of the revenue was 1,802,570 pagodas. In ancient times these provinces formed part of the Hindoo kingdom of Bijanagur; and many of the modern polygars claim their descent from the officers, and some from the royal family, of that kingdom. On the fall of the Mogul government it was broken into several independent states. It was conquered by Hyder between the years 1766 and 1780, but in 1800 was transferred to the British.

BALAGUER, a city of the province of Catalonia, in Spain. It is situated on the river Segra, in a fruitful district, is fortified and defended by a citadel, and contains 4200 inhabitants, who are chiefly occupied in the pursuits of agriculture. Long. 1. 24. E. Lat. 41. 43. N.

BALAMBANGAN, a rich and fruitful island in the Eastern Seas, situated between Magindanao and Borneo, from the latter of which it is 15 miles distant. The East India Company formerly had a settlement here; but it is now abandoned, and is uninhabited. Long. 117. 5. E. Lat. 7. 15. N.

BALAMBUAN, or **PADAMBUAN**, a strong town of Asia, in the Indies, on the east extremity of the island of Java; and capital of a territory of the same name. Long. 114. 10. E. Lat. 7. 50. S.

BALANCE, a machine for ascertaining the weight of substances. There are several kinds of balances, as the common balance or scales, the steelyard, the Danish or Swedish balance, the Chinese balance, the hydrostatic balance, &c. The same name is also given to certain kinds of apparatus employed for measuring or comparing the intensities of very small forces, as the balance of torsion, the electric balance, &c.

The common balance, which is of the most extensive use in the affairs of life, as well as in the arts and experi-

Balaghaut || **Balance.**

Balance. mental physics, consists of a beam, AB (fig. 1, Plate CIII.), supported in the middle by a fulcrum or prop C, round which it turns freely, and having a scale or dish attached to each of its extremities A, B, one of which holds the weight, and the other the substance to be weighed. The balance, therefore, in reference to the mechanical powers, is a lever of the first kind; that is to say, having the fulcrum placed between the power and the weight to be raised; hence its theory is easily deduced from the statical properties of the lever. Let P represent the weight in the scale D, and Q that in E; then (supposing AB an inflexible straight line without weight), when AB becomes stable in the horizontal position, or when P balances Q, the condition of equilibrium is expressed by the equation

$$P \times AC = Q \times BC.$$

In order, therefore, that the two bodies P and Q may have precisely the same weight, or both exert the same force in turning the beam about its axis of motion, it is indispensable that the two points of suspension A and B be exactly equidistant from the fulcrum C.

When the two arms of the balance are not exactly of the same length, it is obvious that the two weights P and Q, which, in the case of equilibrium, are reciprocally as CA and CB, must also be unequal, in order that the foregoing equation may still be true. If, for example, AC is longer than CB, then a less weight in D will balance a greater in E; and it is on this principle that false balances are constructed. The fraud, however, may be easily detected by transferring the weights P and Q to the opposite scales; for then the less weight P being attached to the shorter arm CB, the product $P \times CB$ will be smaller than $Q \times CA$, and the equilibrium consequently destroyed.

It may be remarked, that the true weight of a body may easily be found by means of a false balance of this kind. It is only necessary to weigh the body first in the one scale and then in the other, and the true weight will be a mean proportional between the two weights thus indicated. To demonstrate this property, let w be the true weight of the body in grains, and suppose that when placed in the scale E it balances p grains in D, and that when transferred to D it balances q grains in E, and makes $m = AC$, $n = BC$; by the statical property of the lever we have the two equations,

$$mp = nw, \quad nq = mw;$$

$$\text{whence } \frac{m}{n} = \frac{w}{p}, \quad \frac{m}{n} = \frac{q}{w};$$

$$\text{therefore } \frac{w}{p} = \frac{q}{w} \text{ and } w = \sqrt{pq};$$

so that w is a mean proportional between p and q , and is consequently found by multiplying those numbers together, and extracting the square root of their product.

In what precedes, the beam has been regarded as an inflexible rod devoid of weight; but in order to investigate fully the properties of the instrument, and the conditions that must be fulfilled in order to render it practically useful, it is necessary to have regard to the weight of the beam, and the position of its centre of gravity in respect of the axis of motion. The great requisites of a good balance are sensibility and stability; that is to say, it ought to be such that a very small weight added to either scale disturbs the equilibrium, and causes the beam to deviate sensibly from the horizontal position; and also such, that when the equilibrium has been disturbed, it may return quickly to a state of rest. In order to discover the construction best adapted to confer these two properties, it is convenient to regard the beam as a bent lever. Let G (fig. 2) be the centre of gravity of the beam, O the middle point of the straight line joining the points of suspension A and B, H'H a horizontal straight line drawn

through C, and GD, OE, BH, AH', perpendiculars to H'H. Make

W = weight of beam,

L = weight of scales with their load,

P = the preponderating weight,

$\phi = COE = BOK = \text{angle of inclination.}$

The condition of equilibrium is now

$$L \cdot CE + W \cdot CD = P \cdot CH;$$

whence, since $CH = EH - EC = OK - EC$,

$$L \cdot OC \sin. \phi + W \cdot GC \sin. \phi = P \cdot OB \cos. \phi - P \cdot OC \sin. \phi;$$

$$\text{therefore, } \sin. \phi [(L + P) \cdot OC + W \cdot GC] = P \cdot OB \cos. \phi;$$

$$\text{and } \tan. \phi = \frac{\sin. \phi}{\cos. \phi} = \frac{P \cdot OB}{(L + P) \cdot OC + W \cdot GC}.$$

From this equation it appears that, for any given value of P, the tangent of the angle of inclination, which measures the sensibility of the balance, is directly as the length of the beam, inversely as the weights of the beam and load, and also inversely as the distances of G and O from the axis. The sensibility is therefore greatest when the quantity $(L + P) \cdot OC + W \cdot CG$ is the least possible. On the other hand, when $P = 0$, the stability, or the force acting to restore the beam to the horizontal position, is $\sin. \phi [L \cdot OC + W \cdot CG]$, which will be diminished by diminishing the value of $L \cdot OC + W \cdot CG$.

In what precedes we have supposed the points G and O both to fall below the centre of the motion C; but the balance may be constructed so that one or both of these points shall coincide with C, or fall above it. Suppose, in the first place, the arms to be bent upwards, so that O falls above the fulcrum, while G remains below it. In this case the measure of stability is $\sin. \phi (W \cdot CG - L \cdot OC)$, whence it appears that a balance of this sort can only be used for small weights; for if the load is increased till $L \cdot OC$ becomes equal to $W \cdot CG$, the balance has no restoring power, and is indifferent to any position. If $L \cdot OC$ exceeds $W \cdot CG$, it would entirely upset by the slightest deviation from the horizontal position.

Suppose next that the centre of gravity G falls above the fulcrum, O remaining below it. The measure of stability now becomes $\sin. \phi (L \cdot OC - W \cdot CG)$, and consequently the balance is only useful for heavy weights; for as $L \cdot OC$ is diminished, the stability is lessened, and when $L \cdot OC$ is equal to or less than $W \cdot CG$, the balance is useless. Hence it appears that when either of the points G, O, falls above C, the balance can only be employed in particular cases.

Let the point G coincide with C, and O fall below it. In this case CG vanishes, and the measure of stability becomes $\sin. \phi L \cdot OC$, which, for any given value of ϕ , increases with the load, or the weight of the substance to be weighed. A balance of this sort would be unfit for weighing small bodies on account of its want of stability, though it might be used in the estimation of great weights.

Lastly, let O coincide with C, while G falls below the axis. The three points of action A, C, B, are now arranged in a straight line, and the measure of stability is $\sin. \phi W \cdot CG$, which is constant for a given value of ϕ . The restoring force is therefore independent of the load in the scales, so that a balance of this sort can be employed in all cases, whether the weights are great or small; and as it is easy, diminishing W and CG, to give it any required degree of sensibility, it is this form that ought to be adopted in every case where great precision and accuracy are necessary.

Another reason for this disposition of the three points of action in a straight line is, that unless C is in the same straight line with A and B, an equilibrium will subsist between two unequal weights when AB is not exactly horizontal. In fact, since the weights P, Q, suspended from A and B, act in the direction perpendicular to H'H, the mo-

Balance. ments of these weights, or their energies in turning the beam round its axis, are respectively $P \times CH'$, and $Q \times CH$; therefore, when BCH is a greater angle than ACH' , and the line CH consequently less than CH' , a smaller weight at A will balance a greater at B , and the beam remain at rest though loaded with unequal weights. It is hence important, in all accurate weighing, to make certain that when the equilibrium takes place, the line AB is exactly horizontal.

Having determined from theory the conditions that ought to be observed in the construction of the balance, we shall now proceed to give a brief description of the instrument as it is constructed for assaying or other delicate purposes. In the first place, the beam ought to be as light as possible, consistently with its perfect inflexibility; for it is evident that the friction of the axis will be increased with its weight, and the sensibility proportionally diminished. To combine the qualities of lightness and inflexibility, it is found most advantageous to form the arms of the balance of two hollow cones of brass, very thin, but strengthened and inflexible by means of circular rings driven into them at proper intervals. In order to diminish as much as possible the extent of the surfaces in contact, the axis is formed of two sharp edges of tempered steel, lying in the same straight line, and supported on two planes of steel, agate, or crystal, finely polished, and placed with the greatest precision, in the same horizontal plane. In a balance made by the celebrated Troughton, the sharp edges are ground on the lower side of a cylinder of steel, which crosses the beam in the middle, and they extend over the agate planes about $\frac{1}{20}$ th of an inch. The angle of the edges is about 30° . The suspension at the extremities of the beam ought also to be made by sharp edges, crossing each other at right angles; and in order to obviate any risk of displacement, the edges may be concave, those formed in the beam being sharp upwards, and the others, to which the scales are attached, being sharp downwards. The horizontality of the beam is usually indicated by a slender pointed rod called the *tongue* of the balance, rising perpendicularly above the beam, and passing through the centres of gravity and motion. A divided ivory scale, placed contiguous to it, shows deviations of the tongue from the perpendicular, and renders sensible the slightest motion of the beam. In some balances the tongue is placed below the beam, pointing downwards, in order to diminish the volume of instrument. But the preferable method is to bring the arms themselves to terminate in sharp points, and place a divided scale behind each. By this means the tongue is rendered unnecessary, and any flexure of the beam immediately becomes evident. Care must be taken that the zeros of the two scales be placed exactly in the same level. The points of suspension at the extremities of the arms ought to be adjustable both horizontally and vertically; horizontally, for the purpose of giving the two arms exactly the same length; and vertically, in order to bring the three points of action into a straight line. A nut or bob, formed of some heavy substance, placed near the middle of the beam (in the interior of the cylinder if it be hollow), and capable of being raised or lowered by a screw, serves to increase or diminish the distance of the centre of gravity of the beam from the axis of motion, and consequently to accelerate or retard the oscillations at pleasure. Two supporters, the upper ends of which are formed into angles, are placed under the beam. These, being raised by means of a screw, lift the beam from the supporting planes, and relieve the sharp edges when the balance is not in use. If the arms of the balance are hollow, this object may be accomplished with less risk by placing the supporters under the extremities of the cross steel bar on which the sharp edges are form-

ed. Props should also be placed under the scales while loading or unloading them; and care taken to confine the oscillations within narrow limits, or prevent the beam from deviating much from the horizontal position, by which the points of action might be endangered. The sensibility, as we have seen, increases with the length of the beam; but the liability to flexure also increases in the same proportion: and the arms of a balance, such as has been described, cannot, perhaps, safely exceed nine or ten inches. When great delicacy is required, the apparatus must be protected from the disturbing influences of currents of air, by being inclosed within a glass case, having doors at the ends for the convenience of loading and unloading the scales.

Fig. 3, Plate CIII. represents a balance by Fortin, a celebrated mechanician of Paris. The beam is made of tempered steel, and the arms slightly bent, so that all the parts of action may be situated in the same plane, and the centre of gravity fall a little below the axis of motion, which is here under the beam. The planes of support are of steel, and highly polished. The suspension at the extremities of the arms is represented by fig. 4.

With a balance of great sensibility, weighing is not only a delicate, but also tedious operation. When the adjustments are all perfect, and the beam nearly poised, the oscillations should be extremely slow and regular, and extend to equal distances on each side of the zero of the scale. In fact, it is by the equality of the excursions of the index from zero that the horizontality of the beam must be inferred; for a very long time would elapse before the oscillations entirely cease. The sensibility of a balance constructed with the requisite care, according to the principles above explained, is very great. Those of Fortin of Paris have been found to oscillate by the addition of a single milligramme, when loaded with a weight of 1000 grammes in each scale; so that the weight is indicated to the millionth part. A balance constructed by the late Mr Ramsden, for the Royal Society of London, is said to vibrate with the seven-millionth part of its load. In general, however, no such exactness can be hoped for; and even when the greatest precautions are taken, and the most delicate instruments employed, it would seldom be safe to vouch for the truth of any figure carried beyond the fourth decimal.

But notwithstanding the high state of perfection to which the mechanical arts have arrived, the mathematical equality of the length of the arms, and their symmetry in respect of the axis of motion, can never be practically attained; it is therefore desirable to have the means of obtaining results in as great a degree as possible independent of such extreme precision. The following method of weighing, ascribed by the French writers to Borda, gives results not affected by the inequality of the arms, or other imperfections to which the balance is principally subject, and ought to be practised whenever very great accuracy is necessary. Let the body to be weighed, which we shall call P , be placed in the scale A , and for a counterpoise put into the scale B , substances of any sort, for instance bits of copper, lead, wire, or even chips of paper, added in small quantities till the beam becomes perfectly horizontal, which is known by the index pointing to zero. This being done, remove gently the body P from A , and substitute for it known weights, as grains and fractions of a grain, till the equilibrium is restored, and the index again settles at zero. Now it is evident that the weights in A , having been placed exactly in the same circumstances with the body P , and producing equally with it an equilibrium with the loaded scale B , must be the exact equivalent or weight of P . In fact, the accuracy of this process can only be affected by two circumstances; the

Balance. first is, the friction of the axis, or the want of sensibility in the balance; and the second is, a change of position in the point of suspension. Unless the points of suspension are identical in both operations, the weights which successively produce equilibrium with B will not be exactly equal; for even if no change takes place in the length of the arm, the friction developed at the new points of contact will have a different value, and consequently require a different force to overcome it. The chief objects to be attended to, therefore, in practising the method of double weighing, are, that the mode of contact may receive no change during the loading and unloading of the scales; and that the friction may be reduced to its least possible value by giving the finest polish to the edges, as well as the plane of support.

With regard to the weights that ought to be employed, it may be sufficient to state, that, in delicate weighing, and for philosophical purposes, they are usually reckoned by Troy grains. The geometrical series 1, 2, 4, 8, 16, &c. offers one considerable advantage, namely, that a smaller number of weights is required than when any other system is adopted; but it would, perhaps, be more convenient in practice to follow the decimal division, and use weights of the following values: 1, 2, 3, 4, &c.; 10, 20, 30, 40, &c.; 100, 200, 300, 400, &c.; 1000, 2000, 3000, 4000, &c., up to 9000; and .1, .2, .3, .4, &c.; .01, .02, .03, .04, &c.; .001, .002, .003, .004, &c. By this means the trouble of adding would be entirely avoided, and the number of weights in the scale would equal the digits in the number by which the grains are expressed. Thus a load of 735.4 grains would be counterpoised by weights of 700 grains, 30 grains, 5 grains, and 4-10ths of a grain.

See Euler, *Comment. Petrop.* tom. x. p. 3. *Phil. Trans.* for 1766; Shuckburgh in ditto for 1798, part 2d; Prony, *Annales de Chimie*, tom. xxxvi. p. 3; Biot, *Traité de Physique*, tom. i. p. 9; Ure's *Dictionary of Chemistry*; Leslie's *Elements of Natural Philosophy*, vol. i. p. 185.

The *Steelyard* is a balance by which the weights of bodies are estimated by means of a single weight. This machine, which is represented by fig. 5, is likewise a lever of the first kind, having two unequal arms. The load L to be weighed is suspended from the extremity of the short arm CA, and the counterpoise or constant weight P is movable along CB. Divisions traced on CB indicate the weight of L corresponding to each of the positions of P. In the East, where the steelyard is much in use, the standard weight P is generally made to resemble a pomegranate in shape; whence the instrument acquired the name of *Romman*, and from this circumstance it has frequently but erroneously been denominated the *Roman balance* or *Statera*.

To find the points of division of the arm CB, let W be the weight of the bar AB, exclusive of L and P; and let p be the weight in pounds of the body L. Let $CA = l$, and x be the unknown distance of the centre of gravity of the beam from the fulcrum C. Then, carrying P along the arm CB till the beam is horizontal, let A_1 be the point at which P rests, and put $CA_1 = X_1$. Now, the beam is kept in equilibrium by its own weight acting at the centre of gravity x , and by the weights p and P acting respectively at A and A_1 ; therefore the condition of equilibrium is expressed by the equation

$$Wx + pl + PX_1 = 0.$$

Let another weight p , equal to the former, be suspended from A, and let A_2 be the position of P when the equilibrium is restored. Make $CA_2 = X_2$, and the above equation now becomes

$$Wx + 2pl + PX_2 = 0.$$

In this manner, by the successive addition of equal weights p to A, the following system of equations is formed:

$$Wx + pl + PX_1 = 0$$

$$Wx + 2pl + PX_2 = 0$$

$$Wx + 3pl + PX_3 = 0$$

$$\dots\dots\dots$$

$$Wx + npl + PX_n = 0.$$

By subtracting the first of these equations from the second, the second from the third, and so on, we have

$$pl + P(X_2 - X_1) = 0$$

$$pl + P(X_3 - X_2) = 0$$

$$pl + P(X_4 - X_3) = 0$$

$$\dots\dots\dots$$

$$pl + P(X_n - X_{n-1}) = 0.$$

The successive differences $X_2 - X_1$, $X_3 - X_2$, &c. are therefore constant, each being equal to the constant quantity $\frac{pl}{P}$. The divisions of the arm CB may therefore be found as follows:

Having suspended the given weight p from the extremity of the shorter arm CA, find the point A_1 at which it is necessary to place P in order that the beam may be horizontal. Then, having removed p , substitute for it another weight, which is an exact multiple of p , as np , and let P be moved toward C till the equilibrium is restored, A_n being the point where P is now placed. Divide the distance $A_1 A_n$ into $n - 1$ equal parts, and the points of division will be respectively those at which P will balance the intermediate weights between p and np . If, therefore, each of those points is marked with the corresponding value of p , the weight of any body whatever suspended from A will be indicated by the number of the division at which P rests when the beam is horizontal. The distances $A_1 A_2$, $A_2 A_3$, &c. may be divided into tenths, or other fractional parts.

For weighing heavy loads the steelyard is a convenient instrument; but for small weights it is not susceptible of so much accuracy as the common balance. The pressure on the fulcrum, and consequently the friction, is greater, when the commodities to be weighed are less than the constant weight P, and the subdivision of the arm cannot be effected with the same precision as that of weights for the balance. It may be proper, however, to remark, that the instrument ought to be constructed so that the constant centres C and A may be in the same straight line with the divisions of the beam, and that the centre of gravity of the unloaded beam, when placed horizontally, shall be in the vertical passing through C, and a little below that point, as in the common balance. An index or tongue shows when the beam takes the horizontal situation.

The *Chinese Balance* is a sort of steelyard for weighing small commodities, formed of a slender tapering rod of wood or ivory, about a foot in length, perforated generally with four holes through which silk threads are passed, to serve as so many points of support. Four different sets of divisions are marked on the corresponding sides of the rod; and when any thing is to be weighed, the rod is held up by one of the strings, and a sliding weight of about 1½ ounce Troy employed as a counterpoise to the substance, which is placed in a small scale suspended from the extremity of the shorter arm. The position of the standard weight indicates the weight of the substance, as in the ordinary steelyard.

The *Danish* or *Swedish Balance*, which is commonly employed in many parts of the north of Europe for weighing coarse commodities, is of a very simple construction. It consists usually of a batten of hard wood, having a heavy lump A (fig. 6) fixed at one end, and a swivel hook at the other. The goods to be weighed are fixed to the hook, and the whole is suspended in a loop of whipcord C, in which the rod is slid backward and forward

Balance.

Balance. till the equilibrium is established. The weight of the load L is determined by the position of the loop on a scale of divisions, which may be formed in the following manner.

Let O be the centre of gravity of the beam and the attached weight at A , W their weight, L the load to be weighed, and make $BO = a$, $BC = x$. The equation of equilibrium is $Lx = W(a - x)$, whence $x = \frac{Wa}{L + W}$.

Now, if we suppose a to be 30 inches, $W = 2$ lbs., and substitute for L the numbers 1, 2, 3, &c. successively, we shall have the following values of x :

When $L = 1$, $x = 20$ inches

$L = 2$, $x = 15$

$L = 3$, $x = 12$

$L = 4$, $x = 10$

&c.

A balance constructed in this manner is obviously susceptible of very little accuracy.

The *Bent Lever Balance*, which is represented by fig. 7, is sometimes employed for expedition in the coarser processes of weighing. To one extremity of a bent lever ACB , is attached a constant weight B , which acts as a counterpoise to the load placed in the scale suspended from A . Through C , the point of support, draw the horizontal line DE , and through A and B the perpendiculars AD , BE , meeting DE in D and E . Now the equilibrium will take place when CE is to CD as the load at A to the constant weight B ; and if the arms are bent so that the lines joining CA and CB are at right angles, then as B moves upward, its momentum increases in proportion to the sine of the arc it describes, while the momentum at B decreases in proportion to the cosine of a similar arc. The weight on A corresponding to any position of B , may therefore be expressed on a graduated circular scale placed behind the index at B . Theoretically considered, the range of this balance is very considerable; but the indications are little to be depended on when B approaches either the perpendicular or the horizontal line passing through C .

The *Hydrostatic Balance* is an instrument contrived for weighing bodies in water, and thereby determining their specific gravities.

It is constructed in various forms; but we shall content ourselves here with describing that which appears of all others the most accurate. VCG (fig. 8) is the stand or pillar of this hydrostatic balance, which is to be fixed in a table. From the top A hangs, by two silk strings, the horizontal bar BB , from which is suspended, by a ring i , the fine beam of a balance b , which is prevented from descending too low on either side by the gently springing piece xyz , fixed on the support M . The harness is annulated at o , to show distinctly the perpendicular position of the examen, by the small pointed index fixed above it.

The strings by which the balance is suspended, passing over two pulleys, one on each side of the piece at A , go down to the bottom on the other side, and are hung over the hook at v ; which hook, by means of a screw P , is movable about one inch and a quarter backward and forward, and therefore the balance may be raised or depressed so much. But if a greater elevation or depression be required, the sliding piece S , which carries the screw P , is readily moved to any part of the square brass rod VK , and fixed by means of a screw.

The motion of the balance being thus adjusted, the rest of the apparatus is as follows. HH is a small board, fixed upon the piece D , under the scales d and e , and is movable up and down in a low slit in the pillar above C , and fastened at any part by a screw behind. From the point in the middle of the bottom of each scale hangs, by

a fine hook, a brass wire ad and ac . These pass through two holes m, m , in the table. To the wire ad is suspended a cylindric wire rs , perforated at each end for that purpose. This wire rs is covered with paper, graduated by equal divisions, and is about five inches long.

In the corner of the board at E is fixed a brass tube, on which a round wire hl is so adapted as to move neither too tight nor too free, by its flat head I . Upon the lower part of this moves another tube Q , which has sufficient friction to make it remain in any position required. To this is fixed an index T , moving horizontally when the wire hl is turned about, and therefore may be easily set to the graduated wire rs . To the lower end of the wire rs hangs a weight L ; and to that a wire pn , with a small brass ball g about one fourth of an inch diameter. On the other side, to the wire ac , hangs a large glass bubble R , by a horse hair.

Let us first suppose the weight L taken away, and the wire pn suspended from S ; and, on the other side, let the bubble R be taken away, and the weight F suspended at c in its room. This weight F we suppose to be sufficient to keep the several parts hanging to the other scale in equilibrium; at the same time that the middle point of the wire pn is at the surface of the water in the vessel O . The wire pn is to be of such a size that the length of one inch shall weigh four grains.

Now, it is evident, since brass is eight times heavier than water, that for every inch the wire sinks in the water it will become half a grain lighter, and half a grain heavier for every inch it rises out of the water: consequently, by sinking two inches below the middle point, or rising two inches above it, the wire will become one grain lighter or heavier. Therefore if, when the middle point is at the surface of the water in equilibrium, the index T be set to the middle point a of the graduated wire rs , and the distance on each side ar and as contains 100 equal parts; then, if in weighing bodies the weight is required to the hundredth part of a grain, it may be easily had by proceeding in the following manner.

Let the body to be weighed be placed in the scale d . Put the weight X in the scale e ; and let this be so determined, that one grain more shall be too much, and one grain less too little. Then, the balance being moved gently up or down by the screw P , till the equilibrium be nicely shown at o , if the index T be at the middle point a of the wire rs , it shows that the weights put into the scale e are just equal to the weight of the body. By this method we find the absolute weight of the body; the relative weight is found by weighing it hydrostatically in water, as follows.

Instead of putting the body into the scale e , as before, let it hang with the weight F at the hook c by a horse hair, as at R , supposing the vessel O of water were away. The equilibrium being then made, the index T standing between a and r at the 36 division, shows the weight of the body put in to be 1095.36 grains. As it thus hangs, let it be immersed in the water of the vessel N , and it will become much lighter; the scale e will descend till the beam of the balance rest on the support z . Then, suppose 100 grains put into the scale d restore the equilibrium precisely, so that the index T stand at the 36 division above a ; it is evident that the weight of an equal bulk of water would in this case be exactly 100 grains.

The *Balance of Torsion* is an instrument invented by Coulomb, for comparing the intensities of very small forces. It consists essentially of a metallic wire, suspended vertically from a fixed point, to the lower end of which a horizontal needle is attached, with a small weight for the purpose of keeping the wire stretched. The intensity of any small force made to act on the extremity of

Balance of Power. the needle is measured by the arc which the needle passes over, reckoned from the point of repose. The force is thus balanced by the *torsion* of the wire, whence the name of the instrument.

To prevent any derangement from the agitation of the air, the apparatus must be covered by a glass cylinder, to which a circular scale is applied horizontally, for the purpose of measuring the amplitude of the arc traversed by the needle. A divided circle is also adapted to the top of the cylinder, and capable of being turned round on it, by means of which, and a fixed index attached horizontally to the hook from which the wire is suspended, the wire may be twisted any required number of degrees. This apparatus is represented by fig. 9. The length of the wire and the needle must be regulated by the object in view. If the forces to be measured are very small, and great sensibility is consequently required, the wire

must be long and very fine; for the force of torsion is inversely proportional to the length of the wire, and directly as the fourth power of its diameter. It must also be formed of a substance possessing considerable elasticity, and for this reason brass wire is greatly superior to iron. By experiments undertaken for the purpose, Coulomb found the elasticity of some wires so perfect, that on keeping them twisted through eight circumferences for thirty hours together, the centre of torsion was not displaced by a single degree. Their length was about a metre, or 39 inches.

The balance of torsion is used chiefly in experiments on electricity, magnetism, the adhesion of fluids, &c.; and it was by means of this instrument that Cavendish made his famous experiments on the attraction of lead balls, from which he deduced the mean density of the earth equal to about 5.5, that of water being unit. (s.)

Balance of Power.

BALANCE OF POWER,

AMONG states, a most important principle of foreign policy, intimately connected with the general peace and independence of nations, but which some have treated as altogether chimerical, and others represented as having led only to pernicious results. It is more generally admitted, however, to have a real foundation in the rules of intercourse and union among states, and to have exercised a great and beneficial influence on the affairs of modern Europe. We say of modern Europe, because, though the policy in question was not wholly unknown to other ages and countries, it was nowhere *systematically* pursued but among the European nations of modern times. Previous to the sixteenth century there was little political connection among those nations, their circumstances not being such as to admit of any regulated attention to foreign affairs; but about the commencement of that century they began to form one grand community or federal league, of which the actuating principle was the preservation of the balance of power. The attention to this principle thenceforth influenced all the great wars and negotiations, and made every foreign movement, however remote, an object of interest throughout every part of the European system.

We shall endeavour to sketch a general outline of this important subject; and, in doing so, we shall notice, though in a brief way, all the principal topics which it seems to present for discussion.

Principle of a balance of power, and system founded on it.

I. The ultimate intention of the system founded on the balance of power, is to secure every state in the full possession and enjoyment of all its rights, by making its safety and independence objects of interest and guardianship to its neighbours. It endeavours to accomplish this great end by teaching that it is the interest of all states to check the first encroachments of ambition, to watch every movement of foreign powers, and to unite their respective forces in support of the weak against the strong. It is called the balancing system, because its aim is to prevent any state from aggrandizing itself at the expense of its neighbours, and to counterpoise any state that may have become too powerful, by a union of the forces of others.

The metaphorical terms applied to this system seem to have given rise to some very absurd misconceptions of its true theory and purposes. It has sometimes been supposed that its object was to *equalize* the powers of states composing a common system; and as it is plainly impossible either to effect or to maintain such an equality, it has thence been concluded, that the whole system is founded upon a chimera. But, with a view to the objects of this system, the question is, not what amount of power above

another any state possesses, provided the power so possessed be fairly acquired, but whether any state possesses its power in such circumstances as to enable it to trespass at pleasure on a weaker neighbour. If there be no other state, or confederacy of states, capable of counteracting any injurious designs which a greater power might undertake, then it is said there is no balance; but if there be such a counterpoise, this is all that the balancing system requires to produce what, in its language, is called an equilibrium. In order to make this point as clear as possible, we beg to refer to the following definitions of the balance of power, as given by Vattel and by Gentz: "By this balance," says the former, "is to be understood such a disposition of things, as that no one potentate or state shall be able absolutely to predominate and prescribe laws to the others." (*Law of Nations*, b. iii. c. iii. § 47.)—"What is usually termed a balance of power," says M. Gentz, "is that constitution subsisting among neighbouring states, more or less connected with one another, by virtue of which no one among them can injure the independence or essential rights of another, without meeting with effectual resistance on some side, and, consequently, exposing itself to danger." (*Fragments on the Political Balance*, c. i.)

Thus, then, it is distinctly understood that the balancing system is not grounded upon an *equality* among states in respect of power, but upon a union of powers to repress the enterprises of the strong and ambitious, and to counteract the effects of necessary individual inequalities by aggregate strength.

It is quite indispensable to the existence of such a system, that one state should not be permitted to obtain such a superiority of power as to enable it to overawe all opposition, and make the safety of those around it dependent on its will; and as it is the disposition of all unchecked power to extend itself, the balancing system inculcates it as the interest, as well as the right, of every state to join in opposing the first encroachments of any ambitious potentate or community. It teaches that the danger extends much further than to the party immediately attacked or menaced; that one encroachment will pave the way to another; and that it is therefore wise to meet the danger whilst yet distant, and capable of being combated with less peril or loss. The right of interference to put down a danger of this kind is, in fact, only a modification of the right to resist an immediate attack. All human experience shows, that the state which is suffered to aggrandize itself at the expense of one neighbour, will with

Balance of Power. its increased means acquire stronger dispositions to encroach still further; and therefore self-defence authorizes us to treat as already an invader, any potentate whose conduct entitles us to conclude that he only waits a convenient opportunity to become so in effect. "As long," says Bacon, "as men are men, and as long as reason is reason, a just fear will be a just cause of a preventive war; but especially if it be part of the case that there be a nation that is manifestly detected to aspire to new conquests, then other states assuredly cannot be justly accused for not paying for the first blow, or for not adopting Polyphemus's courtesy, to be the last that shall be eaten up." (*Speech concerning a War with Spain.*) It is peculiarly and emphatically the language of the balancing system, *Principiis obsta*,—in other words, look well to the safety and independence of your neighbours, even the most remote, if you wish to preserve your own.

Upon this point it is by no means necessary to enter into any lengthened deductions. The principle of interference to prevent the progress of a dangerous power rests, both as to right and policy, upon the most obvious dictates of experience and prudence. No state ever yet acquired a preponderating power without abusing it; and therefore it is the right and interest of all states to prevent any one from rising to such an ascendancy as may endanger the common safety.

The right in question, however, is that of guarding against injury justly to be apprehended from the conduct of a state which uses improper means of aggrandizement. As far, therefore, as measures of hostility are concerned, there must be actual encroachment in order to warrant them. The balancing system does not say there shall be no alterations in the relative strength of states; for a state may fairly and honourably increase her power by wise legislation, or by the cultivation of her own internal resources. To attempt to impede a state which takes this road to greatness, would be to make war upon those very arts by the successful cultivation of which peace and happiness are spread throughout the world. The aggrandizements to which the balancing system stands opposed, are those attended with immediate violence to some, and which infer further violence to others. All that nations can do when a neighbour becomes formidable in a fair way, is to watch her, and to draw closer those ties of alliance which may enable them to counteract any bad use of her power. When Lord Bacon, in his *Essay on Empire*, counsels princes "to keep due sentinel, that none of their neighbours do so overgrow by increase of territory, by embracing of trade, by approaches or the like, as to become more able to annoy them than they were," he does not mean that the growth of a state by commerce is to be prevented in the same way as in the case of its extension by a seizure of territory, but, that all great power, however acquired, is in its nature dangerous, and ought to be counterpoised by timely confederation.

There is another way in which a state may become formidable, and that of a sudden, where the balancing system does not authorize immediate hostile interference. We allude here to the case of a sovereign who acquires a great accession of power by marriage or by inheritance. "It is a sacred principle of the law of nations," says Vattel, "that such an increase of power cannot, *alone and of itself*, give any one a right to take up arms in order to op-

pose it." (B. iii. c. 3, sect. 43.) Grotius and Puffendorf maintain the same opinion in terms equally decided. But, suppose a sovereign, who has already displayed an encroaching disposition, is about to acquire in this way an accession of power, which would render him more and more formidable to his neighbours; in this case, as Vattel shows, the maxims of the balancing system authorize an immediate interference to procure securities; or, according as the danger is imminent, altogether to prevent the impending aggrandizement. It is perhaps wholly unprecedented, as this writer observes, that a state should receive any remarkable accession of power, without giving other states just grounds to interfere; but if it should be otherwise, the only course to be pursued is that which the balancing system recommends, namely, to keep a watchful eye on all the proceedings of the formidable state, and the formation of a counterpoise by means of alliances.

These, then, are the grand expedients of the balancing system: vigilant inspection to discover, and prompt union to counteract, in their birth, all such projects of encroachment as powerful states will ever, when opportunity offers, be ready to form. By employing resident agents to procure speedy information, and by the weight of joint warnings and reclamations in every case of apprehended or of real injury, the balancing system furnishes the only peaceful means which human wisdom can devise to control the conduct of independent states; the only means which can be employed to guard against injustice, or obtain redress, without an actual appeal to the sword. It was the *habitual* employment of these expedients, with a view to guard against distant dangers, that distinguished the balancing system, as exemplified in modern Europe, from those momentary efforts and loose confederacies in which all nations, and even the rudest tribes, have occasionally united, in order to repel or pull down a powerful and common enemy.¹ Without this habitual attention to foreign affairs, and constant application of the principles of counterpoise, there cannot, indeed, be said to exist any thing like a system of reciprocal guarantee of the independence of nations, such as is involved in the idea of a balance of power.

What particular alliances each state ought to form, with a view to maintain this balance, is a matter of circumstances, and must accordingly vary with them. The object of the system is always the same,—to preserve such a distribution of power amidst the varying relations of states, as shall most effectually check the spirit of encroachment, and confine every potentate to his own dominions.

In the preceding observations we have had it in view to give a general idea of the nature, intention, and means of maintaining a balance of power among a number of connected nations of different degrees of power and magnitude. But before proceeding to any remarks on the history and results of this branch of policy, we shall recapitulate, in the words of M. Gentz, those fundamental maxims which constitute the necessary conditions of the beneficial existence of such a system as we have described. These are,—

"That no one state in the common system must ever become so powerful as to be able to coerce all the rest put together;—

"That, if the system is not merely to exist, but to be maintained, without constant perils and violent concus-

¹ "The grand and distinguishing feature of the balancing system is the perpetual attention to foreign affairs which it inculcates; the constant watchfulness over every nation which it prescribes; the subjection in which it places all national passions and antipathies to the fine and delicate view of remote expediency; the unceasing care which it dictates, of nations most remotely situated, and apparently unconnected with ourselves; the general union which it has effected of all the European powers obeying certain laws, and actuated in general by a common principle; in fine, the right of mutual inspection, universally recognized among civilized states in the rights of public envoys and residents." (Brougham's *Colonial Policy*, b. iii. sect. 1.)

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“That if ever a state attempts, by unlawful enterprise, to attain, or does in fact attain, to a degree of power, which enables it to defy the danger of a union of several of its neighbours, or even of the whole, such a state should be treated as a common enemy; and if it has acquired that degree of force by an accidental concurrence of circumstances, without any acts of violence, whenever it appears upon the public theatre, no means which political wisdom can devise for the purpose of diminishing its power should be neglected or left untried.” (*Fragments upon the Political Balance*, c. 1.)

Ancient knowledge of the balance of power, and rise of the modern system.

2. The knowledge of the ancients in regard to these great principles of national safety, and the period when they came to obtain a decided influence among the moderns, are points of considerable historical interest. Mr Hume has proved, in a very satisfactory manner, that the principle of preserving a balance of power is distinctly to be recognised in many of the great political transactions of the ancient world. The same thing had previously been shown by Kahle, a famous physician and professor, in a learned and able work, of which a French translation by Formey, entitled *La Balance de l'Europe*, was published at Berlin in 1744. The anxiety of the Greeks with regard to the principle of equilibrium among states was particularly manifested in that famous league against the rising power of Athens which produced the Peloponnesian war. Athens herself showed that she both knew and practised this policy, by constantly throwing her power into the lighter scale, when Thebes and Sparta came to contend for the mastery of Greece. Mr Hume also traces the influence of this salutary principle in the contests which arose among the successors of Alexander; their attention to it having “preserved distinct, for several ages, the partitions made after the death of that conqueror.” (*Essays*, vol. i.) The orations of Demosthenes frequently display very clear and extensive views in this branch of policy. In that for the Megalopolitans, in particular, “we may see,” according to Mr Hume, “the utmost refinements in the balance of power that ever entered into the head of a Venetian or English speculatist;” and by a later writer this speech is also pointed out as “containing discussions of some of the most delicate parts of the theory.” (Brougham’s *Colonial Policy*, b. iii. sect. 1.) All who peruse this remarkable oration with due attention must indeed perceive that it fully bears out this character. Its reasonings may be analyzed into these leading doctrines of the balancing system: that it is the interest of every state to prevent the formation of a predominating power; that to this end the first encroachments ought to be promptly checked; and that it is necessary to join even a rival against a former friend, when that friend would otherwise infringe upon the balance.¹

It seems, in short, to be no longer a question, that it was only with the *phrase*, and not the *idea*, of a balance of power, that the ancients were unacquainted. But we cannot agree with Mr Hume when he goes so far as to say that this principle, though it has been more generally known and acknowledged in modern times, has not had an authority much more extensive in practice, than it had among the nations of antiquity. (*Essays*, vol. i.) This opinion stands clearly refuted by all the great facts, and

by the whole tenor of modern history, from the commencement of the sixteenth century. It was the more constant operation of the principle in question which gradually formed the nations of Europe into one great republic or federal league, whose common bond of union was the guarantee which it afforded of their respective independence. But neither, on the other hand, can we agree with Mr Brougham, when he affirms that the ancient states displayed nothing beyond a mere speculative knowledge in this department. (*Colonial Policy*, b. iii. § 1.) It may be very true that those more enlarged ideas of foreign policy which Demosthenes disclosed in some of his orations were not generally understood or acted upon by his contemporaries; but it is nevertheless perfectly clear, from Mr Hume’s statements, the accuracy of which has never been called in question, that among the Grecian states the maxim of preserving a balance of power, though it had not produced any course of policy so regular and authoritative as the modern international system, was yet, on many occasions, the sole moving spring of their wars and alliances.

This maxim, indeed, lies so much within the sphere of common sense, that it can scarcely fail to be attended to, wherever there is a collection of states capable of observing and attacking each other. But circumstances may be more or less favourable to the growth of a consistent policy in this respect. In modern Europe, a number of considerable states were formed under such circumstances as tended peculiarly to promote a regular intercourse among them, and consequently to develop and systematize this great principle of national security. But it did not begin to manifest itself until, in the gradual and similar progress of European society, the power of the sovereigns of these states was so far consolidated as to enable them to give part of their attention to foreign affairs, and to maintain armies beyond their own frontiers. It was in Italy, where civilization was more advanced, and where there existed a number of small states and commonwealths whose safety required that their rulers should reciprocally keep watch on each other, that the modern system of interference took its beginnings. From an early period of the fifteenth century, we see the balance of power as constant an object of concern among these states as, in the next, it came to be throughout Europe. “Their jealousy of each other,” says Guicciardini, “made them watchful of every motion or measure which they conceived might any way increase the power of their neighbours;” and he presents a splendid picture of the beneficial effects, the long peace, and general independence, attendant upon this habitual attention to the balancing principle. (*History of Italy*, b. i.)

It was about the end of the same century that these ideas began to extend to other quarters, and to actuate the movements of greater potentates. There were now several princes possessed of large kingdoms, with powers and prerogatives which enabled them to take part in distant wars and negotiations. The first great movement of an ambitious neighbour would naturally, therefore, excite their jealousy, and bring them into concert. Thus, when Charles VIII. of France, in 1494, invaded Italy and laid claim to Naples, the sovereigns of Germany and Spain saw the expediency of listening to the Italian princes, who suggested a confederacy to prevent France from gaining an accession of power which could not but render her a dangerous neighbour. Dr Robertson regards

¹ There is a passage of Polybius, which has been frequently quoted as pointing out the leading aim of the balancing system in terms the most explicit. The historian, after mentioning that Hiero, king of Syracuse, acted wisely in assisting the Carthaginian in the war of the auxiliaries, adds, “Nunquam enim ejusmodi principia contemnere oportet, neque tanta cuiquam astruenda est potentia, ut cum eo postea de tuo quamvis manifesto jure disceptare ex æquo non queas.” (*Lib. i. cap. 83.*)

Balance of Power. the expedition of Charles as the first great exertion of those new powers with which the progress of society had invested the princes of Europe; and views the confederacy formed against him, as the first considerable extension of those ideas of a balance of power whose influence had hitherto been limited to the narrow sphere of Italian politics. "From this era," he says, "we can trace the progress of that intercourse between nations which has linked the powers of Europe so closely together, and can discern the operations of that provident policy which, during peace, guards against remote and contingent dangers, and in war has prevented rapid and destructive conquests." (*View of the Progress of Society in Europe*, § 2.) If we look only a little later, we shall everywhere see a constant jealousy of the increase of power, and a vigilant attention to all foreign operations, combined with the application of those means of safety which peculiarly distinguish the balancing system. "During that triumvirate of kings," says Lord Bacon, in his usual expressive language, "Henry VIII. of England, Francis I. of France, and Charles V., Emperor, there was such a watch kept, that none of the three could win a palm of ground, but the other two would straightways balance it, either by confederation, or, if need were, by a war; and would not, in any wise, take up peace at interest." (*Essays on Empire*.)

It has been objected to Dr Robertson that he has represented "the principle of the balance of power as a discovery made by the Italian politicians in consequence of this invasion of Charles; whereas it was not to any such single event that the balancing system owed either its origin or refinement, but to the progress of society, which placed the whole states of Europe in the same relative situation in which the states of Italy were at that period, and taught them not to wait for an actual invasion, but to see a Charles at all times in every prince or commonwealth that should manifest the least desire of change." (Brougham's *Colonial Policy*, b. iii. § 1.) What is here said as to the origin of the balancing system is no doubt true. We have already stated that the principle on which it rests is a principle of our common nature, which cannot fail to manifest itself in certain situations; but that nations must have arrived at an advanced stage of civilization and intercourse before it can be acted upon with consistency and concert. It would therefore be absurd to represent that system as taking its rise in any single event, or its principle as a discovery of some long-sighted statesman. But Dr Robertson knew human nature too well to seek the origin of this principle in an accidental occurrence; and he knew history too well to fix its origin "as a consequence" of Charles's invasion. On the contrary, throughout the whole of his masterly chapter on the progress of the nations of Europe, with respect to the command of the national force requisite in foreign operations, he speaks of this system as holding progress with the growing improvement and intercourse of these nations; and, so far from representing the principle of the balance of power as a discovery consequent upon the event alluded to, he expressly speaks of the league against the French monarch as only exemplifying an extension of those ideas which had long been familiar to the Italian statesmen "in regulating the operations of the petty states in their own country." (*View of the Progress of Society*, § 2.)

Before concluding these very general remarks on the rise of the balancing system in modern times, we shall briefly advert to a conjecture of M. Villers upon this subject, which occurs in his able work on the Reformation. Long before the states of Europe became united in a general system, Italy and Germany, he observes, had formed partial systems, with a view to restrain the members with-

in them, each by the other, and thus maintain a balance of power. It is possible, he adds, that the idea of the general balance of Europe may have been copied from these partial confederacies. (*Essai sur l'Esprit et l'Influence de la Réformation*, 2de partie.) This conjecture, if we rightly understand the learned author, appears to us exceedingly unphilosophical. The states of Europe embraced the idea of a balance of power in proportion as their circumstances enabled them to act upon it, and not in consequence of any estimate of its effects, as displayed on those earlier and narrower stages of its agency.

3. It appears, then, to have been about the beginning of the sixteenth century that the principle of maintaining a balance of power came to be generally recognised and acted upon by the states of Europe; "at first," as M. Gentz says, "more in a practical way, and, as it were, from political instinct, but afterwards with clear, reflecting, and methodical constancy." (*Fragments*.) What the advantages were which Europe reaped from this course of policy we shall endeavour to show, after we have adverted to certain arguments generally employed by those who wish to give an unfavourable view of the balancing system.

By some this system is represented as productive only of wars; as but a convenient pretext to cover projects of ambition, or to screen the restless movements of national jealousy. Others talk of it as being merely a brilliant conception, and appeal to the many violences and usurpations which modern history records, as proofs, if not of its nonentity, at least of its inefficacy. But there is surely no great respect due to that sort of estimate of the system which is founded solely on the abuses to which it is liable, or upon imperfections from which no human institution is free. They who decry or who ridicule the balancing system should be prepared to show, not that it has sometimes afforded plausible pretexts for unnecessary wars, or has sometimes failed to protect the weak against the outrages of the strong, but that it is wholly useless to interest ourselves in the safety of neighbouring nations; to take any trouble to avert dangers which are yet distant; or to seek to strengthen ourselves against a powerful enemy with any strength not our own. This view of things, were it to prevail, would, as M. Gentz observes, open the most desirable prospects to every sovereign whose power and ambition might prompt him to aspire to universal domination.

It must, we think, appear obvious to every one who reflects upon the subject, that the balancing system is, upon the whole, favourable to peace. The wars which peculiarly belong to it are in the nature of a sacrifice of a smaller present, to secure a greater future good; and the tendency of the system is to render these wars less and less frequent. The evil passions which give rise to ambitious attacks, like all other evil passions, will be more apt to be indulged the less exposed they are to opposition or restraint. And it cannot be questioned that, in proportion as the maxims of this system are vigilantly and steadily pursued, there will be less inducement, because less prospect of success, for ambitious undertakings.

Its object is to alarm, and to arm all against the prince whose power prompts him to transgress upon others; and the prince who knows that all his motions are keenly watched, and that his first successes would only expose him to a more extended contest, must see how hopeless would be any attempt to possess himself of the territories even of the weakest of his neighbours. Such is the general tendency of the system; and however it may have occasionally failed to prevent outrages, it cannot be doubted that it has proved a formidable barrier against conquest, and a rampart of defence to the weaker states.

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The complaint of a certain class of French politicians, alluded to by Mr Burke in his *Letters on a Regicide Peace*, "that Rome had frequently acquired more territory in a single year, than all the power of France, actuated by all her ambition, had enabled her to acquire in two centuries," forms, in fact, though unintended, one of the finest panegyrics that could have been pronounced upon the salutary influence of the modern system. The advocates of that system can, indeed, appeal to history for the most satisfactory of all proofs of its efficacy, in the remarkable fact, that, for a period of nearly three centuries, no European state, however small, has lost its independence from external violence. When we recollect the number of small states which, during so long a period, enjoyed an independent existence in the immediate neighbourhood of powerful nations, and reflect for a moment on those evil passions which have, in all ages, prompted the strong to prey on the weak; we must admit that, but for that salutary jealousy of power, and united resistance to its encroachments, which it was the object and office of this system to nourish and enforce, these otherwise helpless states would have been speedily absorbed, or their independence annihilated, by the mighty masses with which they were in contact. It was not the preservation of such countries as Portugal or Holland, of Sweden or Denmark, which, though small compared with many others in the system, were yet possessed of considerable means of self-defence;—it was not the preservation of such states as these merely, but of a multitude of feeble communities in Germany, in Switzerland, and Italy, which affords the proudest proof of the salutary influence of the balancing system on the fortunes of modern Europe. "Consider, for instance," to use the impressive words of a distinguished writer and orator, "the situation of the republic of Geneva; think of her defenceless position in the very jaws of France; but think also of her undisturbed security, of her profound quiet, of the brilliant success with which she applied to industry and literature, while Lewis XIV. was pouring his myriads into Italy before her gates; call to mind that happy period when we scarcely dreamt more of the subjugation of the feeblest republic of Europe, than of the conquest of her mightiest empire; and say whether any spectacle can be imagined more beautiful to the moral eye, or which affords a more striking proof of progress in the noblest principles of true civilization." (Mackintosh's *Speech on the Trial of John Peltier*, in 1803.)¹

Such were the results of the system founded on the balance of power. It was a bridle upon the strong and a bulwark to the weak. When it failed to prevent the in-

roads of violence and injustice, it yet acted as a restorative principle, and replaced injured nations in their former state of independence. It was at the memorable and fatal era of the partition of Poland in 1772 that it first lost this character; that the first example was set of a deliberate, successful, unchecked conspiracy against the independent existence of an unoffending country. It is here proper to mention, that some authors have spoken of this infamous transaction in terms which seem to imply that it was quite in consonance with the principles of the balancing system.² It is indeed true, that the maxims of that system were still so far operative as to effect a relative equality in the division of the spoil. But as the whole intention of this system is to maintain the integrity and independence of nations against unlawful attacks, the partition was just as diametrically opposite to its principle, as if the whole spoil had been appropriated by one robber, instead of being shared by three. The equality of the division did not take away from the danger of the example; the example of states combining, not to uphold, but to destroy,—not to enforce respect to the great principles of national safety, but to set them at defiance; an example too soon followed by similar violences, and which, in fact, paved the way for that total overthrow of the ancient system of Europe which ere long took place.

The origin of a project so pernicious in its consequences is a matter of some interest in the history of the balancing system. We learn from Rulhière's *Histoire de l'Anarchie de Pologne*, published in 1807, that the distractions of this country had suggested the project of a partition as early as 1658; that a Swedish minister, named Stippenbach, proposed it to his own court, to Austria, and the grand duke of Prussia, whose armies were then in possession of the country; and that it would, in all probability, have been acted upon but for the discovery of the scheme by France, and the consequent interference of that power.³ With regard to the project actually carried into execution in 1772, each party concerned was desirous to shift the blame of the first proposal on the others; but it was generally believed to have originated with Frederick, though some were of opinion that he was indebted for the idea to his brother, Prince Henry. Frederick, however, in one of his posthumous pieces (*Mémoires de 1763 jusqu'à 1775*), states that the scheme was devised by the empress Catharine; and this is corroborated by M. Rulhière, who asserts that she communicated it to Prince Henry during his visit to St Petersburg in 1770; a piece of information, he adds, which was detailed to him in the most circumstantial manner, by three different secretaries, who

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¹ We shall here add a striking passage in reference to our subject from this celebrated oration. "These small states were, in many respects, one of the most interesting parts of the ancient system of Europe. Unfortunately for the repose of mankind, great states are compelled, by regard to their own safety, to consider the military spirit and martial habits of their people as one of the main objects of their policy. Frequent hostilities seem almost the necessary condition of their greatness; and, without being great, they cannot long remain safe. Smaller states, exempted from this cruel necessity—a hard condition of greatness, a bitter satire on human nature—devoted themselves to the arts of peace, to the cultivation of literature, and the improvement of reason. They became places of refuge for free and fearless discussion; they were the impartial spectators and judges of the various contests of ambition which from time to time disturbed the quiet of the world. They thus became peculiarly qualified to be the organs of that public opinion which converted Europe into a great republic, with laws which mitigated, though they could not extinguish, ambition; and with moral tribunals to which even the most despotic sovereigns were amenable. If wars of aggrandizement were undertaken, their authors were arraigned in the face of Europe. If acts of internal tyranny were perpetrated, they resounded from a thousand presses throughout all civilized countries. Princes on whose will there were no legal checks thus found a moral restraint which the most powerful of them could not brave with absolute impunity. They acted before a vast audience, to whose applause they could not be utterly indifferent. The very constitution of human nature, the unalterable laws of the mind of man, against which all rebellion is fruitless, subjected the proudest tyrants to this control. No elevation of power,—no depravity, however consummate,—no innocence, however spotless,—can render man wholly independent of the praise or blame of his fellow-men."

² See, for example, the terms in which Count Hertzberg speaks of the partition, in his essay, *Sur la Balance du Commerce et celle du Pouvoir*. (*Œuvres*, tome i.) The language of M. Gentz upon this subject, in his able work, *L'Etat de l'Europe avant et après la Révolution Française*, is extremely exceptionable; but in his later work, referred to in this article, he condemns the partition as wholly inconsistent with, and as having in fact led to the subversion of, the balancing system.

³ "J'ai retrouvé," says M. Rulhière, "dans les archives des affaires étrangères de France, cette anecdote importante, et jusqu'à présent ignorée." (Tom. i. p. 9.)

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accompanied the prince to the Russian court. (Tome iv. p. 151-210.) It seems to be generally acknowledged, that the proposal, when first made to the cabinet of Vienna, was opposed by that power; and that her accession would not have been obtained but for the astonishing apathy displayed by France, and, indeed, by all the other states of Europe. The silence of England during the perpetration of this shameless plot against the independence of nations, if it can be accounted for, can never, at any rate, be excused; inasmuch as the fact appears pretty well established, that, had she, as the guardian of the political balance, raised her voice against the partition, Europe might have been saved from the fatal effects of that new system of robbery and oppression which the spoilers of Poland were suffered, without any sort of interruption, to exemplify. "To my certain knowledge," says Mr Burke, "if Great Britain had at that time been willing to concur in preventing the execution of a project so dangerous in the example, even exhausted as France then was by the preceding war, and under a lazy and unenterprising prince, she would have at every risk taken an active part in this business." (*Thoughts on French Affairs in 1791.*)

Interest of Great Britain in the balancing system.

4. We have still to allude to the question, whether Britain, protected as she is on all sides by nature, ought to consider it as a necessary part of her policy to attend to the European balance of power? This has been considered as constituting a separate question, by some who make no doubt that the other states of Europe could not long preserve their independence secure by any other course. Taking the question generally, we do not think there is any great difficulty in regard to it. With the multitude, to be sure, it always will be popular to argue, that Britain stands in need of no other defence than what the seas and her invincible navy afford her, and that all continental connections are useless or pernicious. But the argument from the advantages of our insular situation would not in fact bear out this conclusion, even were the seas and the navy a stronger defence than it is possible they can always be. Our commerce and our colonies, the supports of that navy, render it indispensably necessary that we should more particularly observe some nations,

and ally ourselves with others. These great concerns make it, indeed, nothing less than absurd to talk of our being *insulated* as an empire or state, because Britain is an island. And, with regard to invasion, it is clear that we could not always be as secure and as free from uneasy apprehensions, in a state of total insulation from foreign connections, as with friends and confederates to employ or oppose a formidable enemy on his own confines.

But supposing the balance of power to constitute a great national object, the line of conduct which that object imposes upon us may, no doubt, be affected by our insular situation. We may on some occasions allow other nations who are more exposed to danger, and who ought, on that account, to be more on the alert to prevent encroachments, to take the first measures, and bear the first expense of resistance. We may watch and warn, and use the influence of our remonstrances and our counsels, without having recourse, except in urgent cases, to the extremity of arms.¹ It is only, in a word, as to the *application* of the general principle, and not as to its being necessary and worthy to be entertained, that there seems any fair room for difference of opinion among British statesmen. In point of fact, all our later statesmen, however differing in other respects, have distinctly assented to the *general* doctrine, that the balance of power was an interest of the highest importance to England. The last time, we believe, that this question can be said to have been fairly brought into debate, and fully discussed in Parliament, was on occasion of the famous armament against Russia for refusing to restore Oczakov to the Porte; and on that occasion, though Mr Fox and his followers reprobated the armament in the strongest terms, they did so, not because they denied the great principle to which the minister appealed, as the sole justification of the measure, that the balance of power was a British concern, and gave Britain an undoubted interest to mingle in the affairs of the continent,—not because they thought that Britain ought never to guard against any distant danger,—but because there was no such degree of danger from the retention of that city and its district, as called upon this country to interfere at the risk of a war.²

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BALASORE, a seaport of Hindostan, in the province of Orissa. It is built along the banks of the Booree Bel-laun river, where the stream is not navigable for vessels of greater burden than 100 tons, and these can only get over the bar at spring tides. The English, Dutch, and Portuguese formerly had factories at Balasore, which was once famed for a manufactory of fine cotton cloths. The English factory was burnt down in November 1688, when, on account of a rupture with Aurungzebe, Captain Heath attacked and plundered the town. The company's servants were at that time carried up the country, and it does not appear that they were ever released. This town was ceded to the Mahrattas in 1751, but was given up to the

English by the Nagpoor rajah at the conclusion of the peace in 1803. The navigation of the Ganges to Calcutta being extremely dangerous, and requiring skilful pilots, it is in Balasore roads that those who undertake that service wait the arrival of vessels. It is 110 miles south-west from Calcutta. Long. 87. 13. E. Lat. 21. 31. N.

BALAYAN, a province of the island of Manilla, in the East Indies. It lies next to the city of Manilla, and extends along the coast on the east side of the island, a little beyond the Bay of Batangas.

BALBEC, a city of Asia, in Syria, anciently called *Heliopolis*, and by the Arabians, "The Wonder of Syria." It is situated at the foot of Anti-Libanus, on the last rising ground where the mountain terminates in the plain.

¹ "Other nations must watch over every motion of their neighbours; penetrate, if they can, every design; foresee every minute event; and take part, by some engagement or other, in almost every conjuncture that arises. But as we cannot be easily nor suddenly attacked, it may be our interest to watch the secret workings of the several councils abroad; to advise and warn; to abet and oppose; but it never can be our true interest easily and officiously to enter into action, much less into engagements that imply action and expense." (Bolingbroke's *Idea of a Patriot King.*)

² Earl Grey, the only survivor of that illustrious group of orators and statesmen who opposed the armament, repeatedly and forcibly declared his adherence to the general doctrine; affirming, that though the epithets *wild* and *romantic* had sometimes been applied to it, he nevertheless considered the poorest peasant in England as interested in the preservation of the balance of power; and that this country ought to interfere whenever that balance appeared to be really in danger. Of all those who joined in this opposition, Mr Burke was the only statesman who did so upon a ground, as it appears to us, equally erroneous in *fact* and *principle*, namely, that Turkey never had been, nor ought to be, taken into consideration, in any question as to the maintenance of the balance of power in Europe. (See *Debates in the House of Commons*, 29th March and 12th April 1791, and 29th February and 1st March 1792.)

Balbec.

From the south, the city is first discovered at the distance of about a league and a half, behind a hedge of trees, over the verdant tops of which appears a white edging of domes and minarets. After about an hour's journey the traveller reaches these trees, which are very fine walnuts; and soon after, crossing some ill-cultivated gardens by winding paths, arrives at the entrance of the city. Here he perceives a ruined wall, flanked with square towers, which ascends the declivity to the right, and traces out the precincts of the ancient city. This wall, which is only ten or twelve feet in height, admits a view of those void spaces and heaps of ruins which are invariable characteristics of every Turkish city; but what principally attracts attention is a large edifice on the left, which, by its lofty walls and rich columns, is soon recognised as one of those temples which antiquity has left for our admiration. These ruins, which are among the most beautiful and best preserved of any in Asia, merit a particular description.

To form a just idea of them, the reader must imagine himself descending from the interior of the town. After crossing the rubbish and huts with which it is filled, the first thing deserving of notice is a vacant space, which appears to have been a square: there, in front, towards the west, is a grand ruin, consisting of two pavilions ornamented with pilasters, joined at their lower angle by a wall 160 feet in length. This front commands the open country from a sort of terrace, on the edge of which are with difficulty distinguished the bases of twelve columns, which formerly extended from the one pavilion to the other, and formed a portico. The principal gate is obstructed by heaps of stones; but, that obstacle surmounted, the traveller enters an empty space, which is a hexagonal court of 180 feet in diameter. This court is strewn with broken columns, mutilated capitals, and the remains of pilasters, entablatures, and cornices; and around it is a row of ruined edifices, which display all the ornaments of the richest architecture. At the end of this court, opposite the west, is an outlet, which formerly was a gate, through which is perceived a still more extensive range of ruins, the magnificence of which strongly excites curiosity. To have a full prospect of these, it is necessary to ascend a slope, at the top of which is the entrance of a square court, much more spacious than the former, being 350 feet in width and 336 in length. The eye is first attracted to the end of this court, where are six enormous and majestic columns nearly entire. Another object not less interesting is a second range of columns to the left, which appear to have formed part of the peristyle of a temple. But the edifices which inclose this court on either side claim attention in the first instance. These form a sort of gallery containing various chambers, seven of which may be reckoned in each of the principal wings, namely, two in a semicircle, and five in an oblong square. The base of the apartments still retains pediments of niches and tabernacles, the supporters of which have been destroyed. On the side of the court they are open, while four columns on the one side and six on the other have been totally destroyed. It is not easy to conceive the use of these apartments; but this does not lessen the admiration excited by the beauty of their pilasters and the richness of the frieze of the entablature. Neither is it possible to avoid remarking the singular effect which results from the mixture of the garlands, the large foliage of the capitals, and the sculpture of wild plants, with which they are everywhere ornamented. In the middle of the court is a little square esplanade, where anciently stood a pavilion, of which nothing now remains but the foundation. With regard to the six columns above mentioned, it is impossible to survey them without being struck with the boldness of their elevation and the richness of their workmanship. Their shafts are

twenty-one feet eight inches in circumference, and fifty-eight in height; so that the total height, including the entablature, is from seventy-one to seventy-two feet. The sight of this superb ruin, thus solitary and desolate, is exceedingly imposing; but a more attentive examination discovers a series of foundations, marking an oblong square of 268 feet in length and 146 in width, which probably formed the peristyle of a grand temple, the primary purpose of this whole structure. It presented to the great court, that is, to the east, a front of ten columns, with nineteen on each side; which, with the six already mentioned, make in all fifty-four. The ground on which it stood is an oblong square, on a level with the court, but considerably narrower, so that there was only a terrace of twenty-seven feet wide round the colonnade; while the esplanade thus produced fronts the open country towards the west, by a sloping wall of about thirty feet. In approaching the city this descent becomes less steep, so that the foundation of the pavilion is on a level with the termination of the hill; whence it is evident that the whole ground of the courts has been artificially raised. Such seems to have been the former state of this edifice; but the southern side of the grand temple was afterwards blocked up in order to build a smaller one, the peristyle and walls of which are still remaining. This temple, situated somewhat lower than the other, presents a side of thirteen columns by eight in front, or thirty-four in all, which are likewise of the Corinthian order, their shafts being fifteen feet eight inches in circumference, and forty-four feet in height. The building they surround is an oblong square, the front of which, turned towards the east, is out of the line of the left wing of the great court. To reach it the traveller must cross trunks of columns, heaps of stone, and a ruinous wall, by which it is now hid. After surmounting these obstacles he arrives at the gate, where he may survey the inclosure which was once the habitation of a god; but, instead of the awful scene of a prostrate people, and sacrifices offered by a multitude of priests, the sky is seen through the open roof, which lets in light enough to show a chaos of ruins covered with dust and weeds. The walls, formerly enriched with all the ornaments of the Corinthian order, now present nothing but pediments of niches and tabernacles, of which almost all the supporters have fallen to the ground. Between these niches is a range of fluted pilasters, the capitals of which support a broken entablature; but what remains displays a rich frieze of foliage resting on the heads of satyrs, horses, bulls, and other animals. Over this entablature was the ancient roof, which was 57 feet in width and 110 in length. The walls which supported it are thirty-one feet high, and without a window. It is impossible to form any idea of the ornaments of this roof, except from the fragments lying on the ground; but it could scarcely have been richer in ornament than the gallery of the peristyle. The principal remaining parts contain tablets in the form of lozenges, on which are represented Jupiter seated on his eagle, Leda caressed by the swan, Diana with her bow and crescent, and several busts of emperors and empresses. It is unnecessary to enter more minutely into the description of this astonishing edifice. The lovers of the arts will find it described with the greatest truth and accuracy in a work published at London in 1757, under the title of *Ruins of Balbec*. This work, compiled by Mr Robert Wood, the world owes to the attention and liberality of Mr Dawkins, who, in 1751, visited Balbec and Palmyra. Several changes, however, have taken place since their journey, and some of the columns then standing have been overturned or destroyed.

When we consider the extraordinary magnificence of the temple of Balbec, we cannot but be astonished at

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the silence of the Greek and Roman authors respecting it. Mr Wood, who carefully examined all the ancient writers, has found no mention of it except in a fragment of John of Antioch, who attributes the construction of this edifice to Antoninus Pius. The inscriptions that remain corroborate this opinion; which, moreover, accounts for the constant use of the Corinthian order, since that order was not in general use before the third age of Rome. But we ought by no means to allege as an additional proof the bird sculptured over the gate; for if his crooked beak, large claws, and the caduceus he bears, give him the appearance of an eagle, the tuft of feathers on his head, like that of certain pigeons, proves that he is not the Roman eagle. Besides, the same bird is found in the temple of Palmyra, and is therefore probably an oriental eagle, consecrated to the Sun, who was the divinity adored in both these temples. Heliolatriy existed at Balbec in the most remote antiquity. The statue of the Sun, which resembled that of Osiris, had been transported thither from the Heliopolis of Egypt; and the ceremonies with which he was worshipped there have been described by Macrobius in his curious collection, entitled *Saturnalia*. Mr Wood supposes, with reason, that the name of Balbec, which in Syriac signifies "City of Bal," or of the Sun, originated in this worship. The Greeks, in naming it *Heliopolis*, have, therefore, only given a literal translation of the oriental word; a practice to which they have not always adhered. We are ignorant of the state of this city in remote antiquity; but it is to be presumed that its situation on the road from Tyre to Palmyra secured it some part of the commerce of these opulent capitals. Under the Romans, in the time of Augustus, it is mentioned as a garrisoned town; and there is still remaining on the wall of the southern gate, at the right of the entrance, an inscription which proves the truth of this; the words *Kenturia Prima*, in Greek characters, being still legible. One hundred and forty years afterwards, Antoninus built the temple above described instead of the ancient one, which was doubtless falling into ruins; but Christianity having gained the ascendancy under Constantine, the modern temple was neglected, and afterwards converted into a church, a wall of which, that screened the sanctuary of the idols, is still remaining. It continued thus until the invasion of the Arabs, when the church, being less frequented, fell into decay; and wars succeeding, it was converted into a place of defence: battlements were built on the wall which surrounded it, on the pavilions, and at the angles which still subsist; and from that time the temple, exposed to the casualties of war and continual dilapidation, fell rapidly to ruin.

BALBRIGGEN, a fishing town of Ireland, in the county of Dublin, with a good quay, where ships of burden can unload and receive their cargoes. It is 19 miles north of Dublin, and its population is 3024.

BALCARRY, a sea-port of Scotland, on the Solway Frith, in the county of Kirkcudbright. It is 10 miles east-south-east of Kirkcudbright.

BALDINGER (ERNEST GODFREY), a German physician of considerable eminence, and the author of a great number of medical publications. He was born near Erfurth, 13th May 1738, and was originally destined for the church; but having acquired a strong predilection for medicine, his father yielded to his wishes, and allowed him to embrace that profession; and he prosecuted his studies with this view both at Erfurth and at Jena. In 1761 he was intrusted with the superintendence of the military hospitals connected with the Prussian encampment near Torgau; and he there gave public lectures with great applause. Having acquired considerable experience in army practice by his assiduous attention to the duties of his of-

fice, he published in 1762 a dissertation on the diseases of soldiers, which met with so favourable a reception from the public, that he enlarged the plan of his work, and republished it under the title of *Treatise on the Diseases that prevail in Armies*, Langensalz, 1774, 8vo. It has since gone through another edition. In 1763 he was appointed professor of medicine at Göttingen, where he enjoyed considerable reputation. The Landgrave of Hesse Cassel, Frederick II., invited him to take up his abode at Cassel, conferring upon him the title of first physician to his court, and director-general of all his medical establishments. He was afterwards professor of the theory of medicine at Jena; and in 1785 was promoted to a professorship at Marburg, where he died of apoplexy on the 2d of January 1804.

His writings are exceedingly numerous; many of them are scattered in various collections and journals; and, besides these, no less than eighty-four distinct treatises are mentioned as having proceeded from his pen. He had collected an extensive library, consisting of 16,000 volumes, of which a catalogue was published after his death. His funeral oration was pronounced by Professor Creutzer. He was well versed in botany, and has published several works on that branch of natural history, of which the following are the principal: *Catalogus Dissertationum quæ Medicamentorum Historiam, facta, et vires exponunt*. Altemburgi, 1768, 4to. *On the Study of Botany, and the Method of learning it*, in German. Jena, 1770, 4to. He was for many years the editor of a periodical work entitled *Magazine for Physicians*, 12mo, Cleves, which afterwards changed its name to the *New Magazine*, in 8vo, from 1779 to 1799. But the principal work of this kind which he conducted was his *Sylloge Opusculorum Selectorum Argumenti Medico-Practici*, being a collection of detached essays and dissertations, which extended to six vols. 8vo. Göttingen, 1766-1782.

His *Litteratura Universæ Materiae Medicæ*, &c. Marburg, 1793, 8vo, is a work of great labour, but little discrimination. He edited Bærner's *Lives of Physicians*, in German. The only other work of his deserving notice, is the *Historia Mercurii et Mercurialium Medica*. Göttingen, 2 tom. 8vo, 1783 and 1785.

BALDINUCCI, PHILIP, a distinguished Italian writer on the history of the arts, was born at Florence about 1624. His chief work is entitled *Notizie de' Professori del Disegno da Cimabue in quà, Secolo v. dal 1610 al 1670*, and was first published in six vols. 4to in 1681-8. An edition in 20 vols. 8vo, with notes by Manni, was published at Florence in 1767-74. Baldinucci died in 1696.

BALDOCK, a market-town of the county of Hertford and Hundred of Broadwater. It is thirty-eight miles from London, on one of the great roads to York. The market is held on Thursday. The town belonged formerly to the knights-templars, who are said to have built the four large churches still remaining there. The population in 1801 amounted to 1283, in 1811 to 1438, and in 1821 to 1550.

BALDOCK, *Ralph de*, bishop of London in the reigns of Edward I. and II., was educated at Merton College, Oxford, became dean of St Paul's, was afterwards promoted to the see of London, and at last was made lord high chancellor of England. He wrote *Historia Anglica*, or a History of the British Affairs down to his own time; and *A Collection of the Statutes and Constitutions of the Church of St Paul*. The former, though it was seen by Leland, is not now extant; the latter is preserved in the library of that cathedral. Bishop Baldock died at Stepney, July 24, 1313.

BALDWIN, archbishop of Canterbury, was born of obscure parents at Exeter, where, in the early part of his

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Bale. life, he taught a grammar-school. After this he took orders, and was made archdeacon of Exeter; but he resigned that dignity, and became a Cistercian monk in the monastery of Ford in Devonshire, of which, in a few years, he was made abbot. In the year 1180 he was consecrated bishop of Worcester. In 1184 he was promoted to the see of Canterbury by Pope Lucius III., and by his successor Urban III. was appointed legate for that diocese. He laid the foundation of a church and monastery in honour of Thomas a Becket, at Hackington, near Canterbury, for secular priests; but being opposed by the monks of Canterbury and the pope, he was obliged to desist. In 1190 he crowned King Richard I. at Westminster, and soon after followed that prince to the Holy Land, where he died at the siege of Ptolemais or St Jean d'Acre. Giraldus Cambrensis, who accompanied him in this expedition, says he was of a mild disposition, and practised great abstinence. He wrote various tracts on religious subjects, which were collected and published by Bertrand Tissier in 1662.

BALE, JOHN, bishop of Ossory, in Ireland, was born at Cove, near Dunwich, in Suffolk, in the year 1495. At twelve years of age he was entered in the monastery of Carmelites at Norwich, and thence sent some years afterwards to Jesus College in Oxford. He was educated a Roman Catholic, but afterwards converted to the Protestant religion by Thomas Lord Wentworth. On the death of Lord Cromwell, the favourite of Henry VIII. who protected him from the persecutions of the Romish clergy, he was obliged to fly into the Low Countries, where he continued eight years. Soon after the accession of Edward VI. he was recalled; and being first presented to the living of Bishop's Stocke in Hampshire, in 1552, he was nominated to the see of Ossory. During his residence in Ireland he was remarkably assiduous in propagating the Protestant doctrines; but to very little purpose, it would seem, and frequently at the hazard of his life. On the accession of Queen Mary the tide of opposition became so powerful that, to avoid assassination, he embarked for Holland; but he was very unfortunate in his attempt to escape, being first taken by a Dutch man-of-war, and robbed by the captain of all his effects, then forced by stress of weather into St Ives in Cornwall, where he was arrested on suspicion of treason. Having obtained his release, however, after a few days' confinement, the ship anchored in Dover road, where he was again seized on a false accusation, but soon liberated. On his arrival in Holland he was kept prisoner for three weeks, but at length obtained his liberty on paying L.30. From Holland he travelled to Basil in Switzerland, where he continued till Queen Elizabeth ascended the throne. After his return to England he was in 1560 made prebendary of Canterbury; and died in November 1563, at Canterbury, in the sixty-eighth year of his age. He was the author of many works, the most noted of which is his collection of British Biography, entitled *Illustrium Majoris Britanniae Scriptorum Catalogus, a Japheto sanctissimi Noë filio ad An. Dom. 1557*. This work was first published in 4to in 1549, and afterwards with various additions in folio in 1559. Ames and Herbert have given the following list of his other works:—1. The Actes of Englysh Votaries, comprehending their unchast practyses and examples by all ages, from the world's beginning to this present year, collected out of their own legendes and chronicles, 8vo, 1546, 1548, 1551, and 1560. 2. Yet a course at the Romyshe Fox, by John Harrison, i. e. Bale, Zurich, 1543. From this was published the Declaration of William Tolwyn, London, date uncertain; Ames says 1542, which must be a mistake. 3. The Apology of Johan Bale agaynste a ranke Papyst, answering both hym and hys doctours, that neyther their

vowes nor yet their priesthode are of the gospel, but of Antichrist; with this, A brefe exposycion upon the xxx chapter of Numeri, London, 1550, 8vo. 4. An Exposition or Complaynt, agaynste the blasphemyes of a frantic Papyst of Hamshyre, with metrical versions of the 23d and 130th Psalms, London, 1552 and 1584, 8vo. 5. The Image of both Churches, after the most wonderful and heavenly Revelation of Sainct John the Evangelist, contayning a very fruitfull exposicion or paraphrase upon the same, first, second, and third parts, London, 1550 and 1584, 8vo. 6. A brefe Chronicle concerning the examinacion and death of the blessed Martir of Christ, Sir Johan Oldecastle, Lord Cobham, 1544 and 1576, 8vo, reprinted also in 1729. 7. The vocacyon of Johan Bale to the Bishoprick of Ossorie in Ireland, his persecucions in the same, and final deliveraunce, London, 1553, 8vo. Herbert mentions two editions in the same year. 8. A Declaration of Edmonde Bonner's Articles, concerning the Cleargye of London Dyocese, whereby that execrable antychriste is in his righte colours reueled in the year of our Lord 1554. Newlye set forth and allowed. London, 156, 8vo. 9. The Pageant of Popes, containing the lyves of all the bishops of Rome, from the beginnunge of them to the yeare of grace 1555, London, 1574, 4to. This is a translation from Bale's Latin edition, by J. S. i. e. John Studley. 10. A new Comedy or Interlude, concerning the Laws of Nature, Moises, and Christ, London, 1562, 4to. This was written in 1532, and first printed in the time of Edward VI. 11. A Tragedie or Enterlude, manifesting the chief promises of God unto man, by all ages in the olde lawe, from the fall of Adam to the incarnation, London, 1577, 4to. 12. A Mystereye of Inyquyte contayned within the heretycall genealogye of Ponce Pantolabus, is here both dysclosed and confuted, Geneva, 1545, 16to. 13. The First Examination of the worthy servaunt of God Mastres Anne Askew, Marpur, 1546, 16to, and the Lattre Examination of the same, *ibid.* 1547. 14. A brieft and faythfull declaration of the true Faith in Christ, 1547, 16to. Mr Herbert conjectures this to be Bale's. The initials only of the author are given. 15. The laboryouse journey and serche of Johan Leylande, for Englandes Antiquitees, &c. London, 1549, 16to, reprinted in the Life of Leland (with those of Wood and Hearne) 1772, and followed there by a memoir of Bale. 16. The confession of the synner after the sacred scriptures, 1549, 8vo. 17. A Dialogue or Communycacyon to be had at a table between two chyl dren, gathered out of the Holy Scriptures, by John Bale for his two yonge sonnes, Johan and Paule, London, 1549. He also translated, 1. Bapt. Mantuanus's Treatise on Death, London, 1584, 8vo. 2. The true hystorie of the Christen departynge of the reverend man D. Martyne Luther, &c. 1546, 8vo. 3. A godly Medytacyon of the Christen Soule, from the French of Margaret queen of Navarre, London, probably 1548, 8vo. Tanner has given a list of his manuscripts, with the names of the places where they are preserved.

BALEARES INSULÆ, or the *Balearic Islands*. The appellation is commonly derived from βαλλειν, *jacere*, because the inhabitants were excellent slingers. They are two in number, the Greater and the Less, or Major and Minor; and hence the modern names *Majorca* and *Minorca*. See **MAJORCA** and **MINORCA**.

BALEN, HENDRICK VAN, historical and portrait painter, was born at Antwerp in 1560. He was a disciple of Adam van Oort, but he quitted that master to acquire a better taste in design and composition by pursuing his studies at Rome, where he resided for a considerable time. He died in 1632. All the historical subjects painted by Van Balen have merit. His designs of the Deluge, of Moses striking the Rock, and the Drowning of Pharaoh,

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are meritorious compositions. His Judgment of Paris is accounted a masterly performance; and the figure of Venus, in particular, is so elegantly designed, so full of life, and so round, that it seems to stand forth from the canvass.

BALES, PETER, a famous master in the art of penmanship, and one of the first inventors of short-hand writing. He was born in 1547, and is described by Anthony Wood as "a most dexterous person in his profession, to the great wonder of scholars and others." We are also informed that "he spent several years in sciences among Oxonians, particularly, as it seems, in Gloucester Hall; but that study, which he used for a diversion only, proved at length an employment of profit." He is mentioned for his skill in micrography, or miniature writing, in Hollingshed's Chronicle, anno 1575; and Mr Evelyn has also celebrated his wonderful skill in this delicate operation of the hand. "Hadrian Junius, speaking as a miracle of somebody who wrote the Apostles' Creed and the beginning of St John's Gospel within the compass of a farthing: what would he have said," adds Mr Evelyn, "of our famous Peter Bales, who, in the year 1575, wrote the Lord's Prayer, the Creed, Decalogue, with two short prayers in Latin, his own name, motto, day of the month, year of the Lord, and reign of the queen, to whom he presented it at Hampton Court, all of it written within the circle of a single penny, inclosed in a ring and borders of gold, and covered with a crystal so accurately wrought as to be very plainly legible; to the great admiration of her Majesty, the whole privy-council, and several ambassadors then at court?" He was likewise very dexterous in imitating handwritings, and about 1576 was employed by Secretary Walsingham in certain political manœuvres. We find him at the head of a school near the Old Bailey, London, in 1590, in which year he published his *Writing Schoolmaster, in three parts*. In 1595 he had a great trial of skill in the Blackfriars with one Daniel Johnson, for a golden pen of L.20 value, and won it; and a contemporary author further relates that he had also the arms of calligraphy given him, which are azure, a pen or. In 1597 he republished his *Writing Schoolmaster*, which was in such high reputation that no less than eighteen copies of commendatory verses, composed by learned and ingenious men of that time, were printed before it. Wood says that he was involved in Essex's treasons in 1600; but this seems to be a mistake, for he was only engaged, and that very innocently, in serving the treacherous purposes of one of the earl's mercenary dependants. We know little more of this curious person than that he seems to have died about the year 1610.

BALEY, WALTER, the son of Henry Baley of Warnwell in Dorsetshire, was born at Portsham in the same county, and educated at Winchester school, from which he was sent to Oxford, and, after two years' probation, admitted perpetual fellow of New College in the year 1550. Having taken his degrees in arts, he practised physic, and in 1558 was proctor of the university. About this time he obtained a prebend of Wells, which he resigned in 1579. In the year 1561 he was appointed queen's professor of physic, in 1563 proceeded doctor in that faculty, and afterwards became one of her majesty's physicians in ordinary. He was thought skilful in his profession, and had considerable practice. He died in 1592, aged sixty-three, and was buried in the inner chapel of New College. His works are, 1st, *A Discourse of three kinds of Pepper in common use*, 1588, 8vo. 2d, *Brief Treatise of the Preservation of the Eye-sight*, first printed in the reign of Elizabeth in 12mo, afterwards at Oxford in 1616 and 1654, 8vo. 3d, *Directions for Health, Natural and Artificial, with Medicines for all Diseases of the Eyes*, 1626, 4to.

BALFRON, a village and parish of Scotland, in the county of Stirling, where a manufacture of cotton was established in 1789, and flourished for some time. The population is 1968, and it is 22 miles north of Glasgow.

BALFROOSH, a large commercial town of Persia, in the province of Mazanderan, about twelve miles distant from the southern shore of the Caspian Sea. It is built in a low, swampy, though rich country; and, from the deep and almost impassable roads which lead to it, seems not at all favourably situated for the seat of an extensive inland trade. It is, however, purely a mercantile city, being peopled entirely by merchants, mechanics, and their dependants; and is wholly indebted for its present size and importance to its commercial prosperity. The town is of a very peculiar structure and aspect. It is placed in the midst of a forest of tall trees, by which the buildings are so separated from one another, and so concealed, that except in the bazars it has no appearance of a populous town. The streets are broad and neat, though generally unpaved; and they are kept in good order. No ruins are to be seen, as in other Persian towns; the houses are comfortable, in good repair, and roofed with tiles, and they are inclosed by substantial walls; and, according to Fraser, by whom it was visited in 1822, it had a plain and simple air of plenty, ease, and comfort, attended with a bustle and show of business which is rarely to be seen in the Persian towns. There are no public buildings of any importance. The only places of interest are the bazars, which extend fully a mile in length, and consist of substantially-built ranges of shops, covered with a roof of wood and tiles, and well stored with commodities. There are about ten principal caravanserais, several of which are attached to the bazar, and are let as warehouses for goods; and not less than thirty medressas or colleges, the place being as much celebrated for learning as for commerce. From a census lately taken by authority, Mr Fraser is of opinion that it contains 200,000 inhabitants. It is 20 miles west of Fehrbad. Long. 32. 40. E. Lat. 35. 55. N.

BALGUY, JOHN, an eminent English divine, was born at Sheffield in Yorkshire in August 1686. He was admitted of St John's College, Cambridge, in 1702, and in 1705-6 took his bachelor's degree, soon after which he quitted the university. In 1711 he obtained a small living, and in 1729 was preferred to the vicarage of Northallerton, in which preferment he remained till his death in 1748. Besides Sermons, an Essay on Redemption, a treatise entitled Divine Rectitude, or a brief Inquiry concerning the Moral Perfections of the Deity, and some other theological tracts, he published a philosophical piece on the Foundation of Moral Goodness, written in answer to Dr Hutcheson's work on the Origin of our Ideas of Beauty and Virtue. Some of these pieces were, by the author himself, collected into one volume, and published with a dedication to Bishop Hoadley.

BALGUY, THOMAS, D. D., son of the above, was born in 1716. After studying at St John's College, Cambridge, where he took his first degree in 1737, he was in 1746 presented to the rectory of North Stoke in Lincolnshire. He afterwards became archdeacon, first of Salisbury, and thereafter of Winchester. He was offered the bishopric of Gloucester in 1781, but was prevented from accepting it by the declining state of his health. He was afterwards afflicted with blindness, and died at Winchester in January 1795. Besides Sermons and Charges, he was the author of a very able and well-known work, entitled Divine Benevolence Asserted and Vindicated from the Reflections of ancient and modern Sceptics. It was published in 8vo, in 1782.

BALHARRY, a town of Hindostan, in Mysore, situated on the west side of the Hagry River, 187 miles

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Balk.

north from Seringapatam, and the capital of the collectorship of the same name, into which, and Cuddapah, the Balaghaut ceded districts are divided. It is a hill fort, with a fortified village. It was taken by Hyder in 1775.

BALI, BALLY, or LITTLE JAVA, one of the Sunda islands, in the Eastern Seas, separated from Java by the straits of the same name, which are five miles wide. It is a large island, being seventy-five miles in length by forty in breadth. A chain of mountains crosses the island in a direction east and west, and terminates on the east in the peak of Bali, which is volcanic. The climate and soil are the same as in Java; it has mountains of proportionate height, and streams well fitted for the purposes of irrigation, and it is equally fertile. But from the mountainous nature of the country, advantage cannot so easily be taken of the periodical rains; and hence the lands are chiefly irrigated from the rivers and streams. Rice is produced in great quantities, and two crops are raised in the year; while in the dry season the lands yield a crop of maize. The other productions are tobacco, oil, and salt, also cotton of an excellent quality; but there are no forests, and the island is supplied with wood from Java. The inhabitants, though originally sprung from the same stock as those of Java, exceed them in stature and muscular power, as well as in activity and enterprising habits. "They have," says Sir Stamford Raffles, "a higher cast of spirit, independence, and manliness, than belongs to any of their neighbours." They are also more moral, not being addicted to drunkenness or licentiousness, though they indulge in the practice of eating opium. Their favourite amusements are gaming and cock-fighting, to which they devote themselves with all the vehemence and energy of their character. They are inferior to their neighbours the Javanese in mechanical art and industry. Cotton is spun into yarn, and made into cloth by the women. Knives, and warlike instruments, such as matchlocks, are also manufactured. The principal exports are rice, birds' nests, coarse cloths, cotton yarn, salted eggs, &c. The imports are opium, betel nut, ivory, gold, and silver. The traffic in slaves was formerly great, and still exists to a certain extent; all prisoners of war, insolvent debtors, and those who attempt to evade the laws against emigration, being reduced to the condition of slaves. The Hindoo superstition is prevalent here, not more than 100 or 200 of the natives being Mahommedans. The island is divided into seven different states, each independent of the other, and subject to its own chief. The total population is estimated at 800,000. (Thorn's *Memoir of Java*, Raffles' *History of Java*, &c.)

BALINDERRY, a village and parish of Ireland, in the county of Antrim, seventy-three miles from Dublin. Its population is 4948.

BALIOL, or BALLIOL, SIR JOHN DE, founder of Baliol College in Oxford, was the son of Hugh Baliol, of Bernard's Castle, in the diocese of Durham, and very eminent on account of his power and riches. During the contests and wars between King Henry III. and his barons he firmly adhered to the king. In 1263 he began the foundation and endowment of Baliol College, which was afterwards perfected by his widow. He died in the year 1269.

BALK, or BULK, was formerly a province of Persia, but is now a dependency of the kingdom of Cabul or Afghanistan. European geographers have but an imperfect knowledge of these countries, situated in the depths of Asia, and defended against the visits of Christian travellers by the fierce intolerance of their inhabitants. The country of Balk is bounded, according to the most accurate accounts, by the Oxus on the north, by the great mountain range of the Hindoo Coosh and Paropamisus on the south, by Badakshan on the east, and generally by sandy deserts on the west. It is supposed to be 250 miles in

Balk.

length from east to west, and from 100 to 120 miles in breadth from north to south. Towards the south the country abounds in hills which branch out from the Hindoo Coosh range. Here the soil is generally stony, though there are many well-watered valleys. The central portion of the country is level, fertile, and well watered from the vicinity of the hills; while towards the north, near the stream of the Oxus, it is sandy and barren. The western part of the country of Balk, which borders on the desert, partakes of its nature; but in the east there are mountainous tracts which are well watered, and occasionally fertile. The country descends very rapidly from the mountain range of Hindoo Coosh, which bounds it on the north, and towards the Oxus is of a lower level and of a much hotter climate than those parts of Afghanistan which lie to the south of these mountains. Balk is inhabited by the Usbeck Tartars, Tanjiks, and Arabs. These races have not relinquished their pastoral habits, some dwelling in tents, although the greater part now resort to the towns. In different parts of the country the soil is good; but it is chiefly occupied by wandering tribes of the Usbecks and Toorcomans, who derive their subsistence from their flocks and herds, and neglect agriculture. The Usbecks are the ruling tribe of Balk, and indeed the principal part of the population. They are generally short and stout, and have the genuine Tartar features, namely, broad foreheads, high cheek-bones, thin beards, and small eyes; yet they are a handsome race compared with the Kalmucks and other Tartar races. Their character is also superior to that of many other Asiatic tribes. They are considered sincere and honest, yet they exercise great barbarity in war, giving no quarter to their enemies, except they mean to sell them for slaves. As rigid Mahommedans, they entertain all the hatred for Christians prescribed by that intolerant creed. In the inaccessible parts of the country of Balk, amidst snowy mountains, deep pine forests, and small but fertile valleys, live a singular race, called by the Mahommedans Kauffers, or unbelievers, and persecuted by them with the most deadly enmity. Mr Elphinstone and Mr Fraser give some curious particulars of this race, who appear to have been the ancient idolaters of the country, and to have taken refuge from their Mahommedan invaders among the fastnesses of the mountains. They are considered extremely savage, but remarkably well formed and beautiful; insomuch that their country is liable to constant inroads from their Mahommedan neighbours, who carry off both men and women into slavery.

The chief cities are Balk, the capital; Meymoonah; Andkhooee; Tansk Koorgha, the capital of Khootoom, consisting of 8000 houses; and another town, the capital of the district of Khoondoo, still larger. This province formed the ancient Bactra. In modern times it was conquered by Nadir Shah, and afterwards reduced by Ahmed Shah, the sovereign of Afghanistan. The country has since experienced many vicissitudes, and been exposed to severe calamities, from the contests for its dominion between different tribes. At present it is ruled by an independent chieftain, Killich Ally, who acknowledges only a nominal superiority to the sovereign of Afghanistan, and whose administration bears a high character for vigilance, liberality, and justice. He exempts all merchants from exactions during their journeys, and inflicts on highway robbery the severest punishments. The population of Balk is estimated at 1,000,000.

BALK, or *Bulk*, formerly a great city, but now an immense and melancholy mass of ruins. It is situated on the river Dehast, in a large and fertile plain. Originally it was regularly built, the streets intersecting each other at right angles; and it contained some splendid bazars

Ballad. arcaded and vaulted, with caravanserais, and many magnificent mosques and colleges. But nothing now remains of its ancient magnificence except such buildings as were constructed of solid brick masonry, and by their strength have withstood the hand of time and the rage of war; so that this once superb capital, denominated the "Mother of Cities," which contained a population of some hundred thousands, has now dwindled to 6000 or 7000, thinly scattered among the ruins of the city. Balk was taken and sacked by Ghengis Khan: it was again taken and destroyed by Tamerlane, who carried the inhabitants without the walls, and massacred them in great numbers; so that a pestilence was created, which raged with great violence, and gave a character of insalubrity to the place. The ruin of Balk was completed by Nadir Shah; and it has never since recovered any degree of consequence. This city is supposed to be the Bactra of the Greeks, and is of high antiquity. Long. 65. 16. E. Lat. 36. 28. N.

BALLAD is a word frequently used as synonymous with *song*: but it properly denotes an historical song, or a song containing a narrative of adventures or exploits, either serious or comic. It is one of the most ancient species of composition, and still constitutes a great portion of the literature of the more uncivilized tribes of mankind. Giovanni Finati, who supplies us with much information respecting the manners and customs of the East, has recorded the following anecdote of ballad-literature among the Benysackr Arabs, whom he found encamped near the shores of the Dead Sea. Their chief, Ibn Fays, he states, "had strangers with him from Damascus, and feasted his guests so plentifully, that the wooden dish out of which we all fed had four iron handles to it, and required three persons to lift it and set it before us. Afterwards, a great earthen pan of grease was lighted as a lamp for the company, and Ibn Fays himself, and his brother, sung a sort of slow plaintive ballad to an instrument with one string, the purport of which was the tragic account of a battle against a neighbouring tribe, in which their own father perished."¹ The leader of this wandering horde might himself be the author, as well as the reciter, of the ballad which thus regaled his guests.

Most of the nations of modern Europe have considerable collections of the ballads which delighted their forefathers; and in some countries the political influence of such compositions has been found to be very powerful. "Of these," says Dr Aikin, "the most copious source is party; and there has seldom been an occasion of political contest in countries permitting such freedoms, in which appeal has not been made to the popular feelings by means of comic and satirical ballads, often with great effect. The share that *Lilliburlero* had in producing the Revolution in this country has been noticed by grave historians. In the war of the Fronde in France, ballads were a weapon as much employed as muskets, and those written for and against Cardinal Mazarin filled several volumes. The French give to these compositions the appropriate title of *Vaudeville*, implying their fitness to walk

the streets; and indeed street-poetry in general belongs to the ballad class."² The Spaniards³ and other nations of the south have preserved ample collections of their early ballads; but the affinity of our own nation and tongue with those of the northern tribes, renders their literary reliques an object of more particular interest. The various tribes of Scandinavians have generally been distinguished for their love of poetry. Many ancient reliques of Islandic poetry are still preserved, and are regarded as very curious specimens of the literature of the different ages to which they belong; nor are the kindred nations of Sweden and Denmark without their early and recent poets, some of whom have attained to high reputation. Of the ballad-poetry of these northern nations, many remnants have descended to our times; and ample collections of Danish, Swedish, and even Feroese ballads have recently been published by respectable editors. "The songs mentioned by Tacitus in his account of the Germans," says Mr Jamieson, "those collected by the order of Charlemagne, and those which the Goths brought with them out of the East, are now not to be found; yet it is more than probable that much more of them is preserved, in however altered a form, than we are aware of; in the elder northern and Teutonic romances, the Danish and Swedish, Scottish and English popular ballads, and those which are sung by old women and nurses, and hawked about at fairs, in Germany."⁴ The same ingenious and well-informed writer has elsewhere expressed his conviction, that many of the traditionary ballads still current in this kingdom have been preserved in the north of England and the lowlands of Scotland, ever since the arrival of the Cimbri in Britain.⁵ Many of our historical ballads may at all events be considered as the productions of a remote period; but it is not to be supposed that they have been transmitted from one generation to another without innumerable transformations. A great proportion of them have doubtless been preserved by oral tradition; and they seem in general to have undergone such changes as brought them nearer to the current speech of each successive generation; for, without this progressive adaptation, the lapse of a few centuries would have rendered them unintelligible to the great body of the people; nor is it usual for any combination of words to be retained in the memory without being understood. Thus, for example, we have reason to believe that the ballad of Sir Patrick Spence derives its origin from a very early age; but the variations to which it must gradually have been subjected, may easily be inferred from a comparison of the different copies which are now to be found.⁶ A story may thus be preserved, when most of the original words have been changed. The close affinity between the old Danish and the old Scottish and English ballads has been noticed by various writers, by Pinkerton, Jamieson, Nyerup, Geijer, and Grimm:⁷ their resemblance is to be traced in the general spirit and contrivance of the poems; while some of the Danish and Scottish ballads exhibit a remarkable coincidence in their particular stories. Whether these effects

¹ *Narrative of the Life and Adventures of Giovanni Finati*, translated by William John Bankes, Esq. vol. ii. p. 272. Lond. 1830, 2 vols. 8vo.

² Aikin's *Essay on Song-Writing* (p. xviii.) prefixed to *Vocal Poetry, or a Select Collection of English Songs*. Lond. 1810, 8vo.

³ See the introduction to Depping's *Sammlung der besten alten Spanischen Historischen Ritter- und Maurischen Romanzen*. Altenburg und Leipzig, 1817, 12mo.

⁴ *Illustrations of Northern Antiquities*, p. 245. Edinb. 1814, 4to.

⁵ Jamieson's *Popular Ballads and Songs*, vol. ii. p. 87. Edinb. 1806, 2 vols. 8vo.—See however Mr Finlay's *Scottish Historical and Romantic Ballads*, vol. i. p. xxv. Edinb. 1808, 2 vols. 8vo.

⁶ Percy's *Reliques of Ancient English Poetry*, vol. i. p. 81. Scott's *Minstrelsy of the Scottish Border*, vol. i. p. 7. Jamieson's *Popular Ballads and Songs*, vol. i. p. 157.—See Mr Motherwell's *Minstrelsy, Ancient and Modern*, p. xlv. Glasgow, 1827, 4to.

⁷ Pinkerton's *Enquiry*, vol. i. p. 364. Jamieson's *Ballads*, vol. ii. p. 87. Nyerup, *Danske Viser*, Bind v. S. 12. Geijer, *Svenska Folk-Visor*, del. i. s. liv.—The affinity between the old English and the old Danish ballads is noticed in the preface (S. xxxi.) to *Altä-nische Heldenlieder, Balladen, und Märchen*, übersetzt von Wilhelm Carl Grimm. Heidelberg, 1811, 8vo.

Ballad. are to be imputed to so remote a cause as the emigration of the ancient Scandinavians, may however admit of much doubt and hesitation. Fiction moves from one region to another with very elastic steps, and in many instances it is impossible to trace her progress.

The earliest collector of Danish ballads was Anders Sörensen Vedel, chaplain to the king of Denmark, and an intimate friend of the celebrated astronomer Tyge Brahe. His publication bears the title of an hundred select Danish ballads, or *Et hundrede vduaalde Danske Viser*. Ribe, 1591, 8vo. It is now a very rare book, even in Denmark; but a copious account of it is given by Nyerup, in the last volume of the more recent collection of *Danske Viser*. After an interval of more than a century, another clergyman, Peder Syv, reprinted this collection of Vedel, and added an equal number of ballads. Kiöbenhavn, 1695, 8vo. But the most extensive collection appeared under the following title: *Udvalgte Danske Viser fra Middelalderen*; efter A. S. Vedels og P. Syvs trykte Udgaver, og efter haandskrevne Samlinger, udgivne paa ny af Abrahamson, Nyerup, og Rahbek. Kiöbenhavn, 1812-14, 5 Bind. 8vo. This work is accompanied with notes and illustrations, and appears to us to possess no inconsiderable value. A similar collection of Swedish ballads was published by Geijer and Afzelius: *Svenska Folk-Visor från Forntiden*, samlade och utgifne af Er. Gust. Geijer och Arv. Aug. Afzelius. Stockholm, 1814-16, 3 del. 8vo. These volumes are accompanied with music, printed in a quarto form. Of Feroese ballads there is a recent collection: *Færøiske Qvæder om Sigurd Fosnersbane og hans Æt*, med et Anhang: samlede og oversatte af Hans Christian Lyngbye, Sognepræst i Gjesing; med en Indledning af P. E. Müller, Dr. og Prof. i Theol. Randers, 1822, 8vo. Dr Müller, the author of the introduction, is a learned and able writer, well known as the author of more important works.

Debes mentions that, at their weddings, and at Christmas, the Feroese were accustomed to "recreate themselves with a plain dance, holding one another by the hand, and singing some old champion's ballad."¹ These islands were peopled in the ninth century by a colony of Norwegians.² The language of the people, as it appears in these ballads, is removed to a considerable distance from the Islandic as well as the Danish. The plan of publishing a Feroese dictionary was formed about half a century ago; and the English prospectus printed upon that occasion furnishes so curious and entertaining a specimen of the language, that we are tempted to insert it with all its peculiarities.

"Subscription.—We are minded after many years troublesome Collection to acquaint the World with the Tongue, used upon the Isles of Fero, a Dialect of the old noble Tongue in former Times written and spoken in Norway, Denmark, Jsland, Swede, and in a good Deal of the english Dominion. Now it appears for the world translated in Latin, Danish, and conferr'd with the islandsh Tongue.

"If we were men of Wealth, we would not forbear to Regard the Expences of printing this Dictionary as a great Trifle, because it, very likely, not will exceed a good Volume in 4to; but we are poor-men. Nevertheless we hope to bring it forth by Way of Subscription and for that Reason We invite hereby our Neighbours, the brave and Reasonable Englishmen to Deal with us the Honour of bringing this Dialect out of the Darkness, wherein it lies, and let it see the Day-Liht. No-Body of our Countrymen, as we know, has thought this before.

"Perhaps this moment in our Life, that has been the

first in Time for this Purpose, will be the Last, and no body afterwards would attend it. The Price will be 2 pence a Sheet and upon good Paper 3 pence.

"N. Mohr. J. C. Svabo."

The two pages which follow are divided into columns, for the *Names of the Subscribers* and the *Number of Exemplars*; but it appears that the well-meaning and pains-taking creatures met with too little encouragement to proceed in their enterprise. The prospectus is without a date; but we learn from Müller and Nyerup that Svabo was employed in collecting Feroese ballads in the years 1781 and 1782. (x.)

BALLAST, any heavy matter, as stone, gravel, or iron, thrown into the hold of a ship, in order to make her sink a proper depth in the water, that she may be capable of carrying a sufficient quantity of sail without upsetting. There is often great difference in the proportion of ballast required to prepare ships of equal burden for a voyage; the quantity being always more or less according to the sharpness or flatness of the ship's bottom, which seamen call the *floor*.

The knowledge of ballasting a ship with propriety certainly deserves the attention of the skilful mariner; for although it is known that ships in general will not carry a sufficient quantity of sail till they are laden deep enough for the surface of the water to glance nearly on the extreme breadth amidships, yet more than this general knowledge is required; since, if a vessel has a great weight of heavy ballast, as lead or iron, in the bottom, it will place the centre of gravity too low in the hold; and although this will enable her to carry a great sail, she will nevertheless sail very heavily, and run the risk of being dismasted in a gale by violent rolling. To ballast a ship properly, therefore, is the art of disposing those materials so that she may be duly poised, and maintain a proper equilibrium on the water, without either being too *stiff* or too *crank*, which are conditions equally pernicious; for in the former case, although the ship may be fitted to carry a great sail, yet her velocity will not be proportionably increased, whilst her masts are more endangered by sudden jerks and excessive labouring; and, in the latter, she will be incapable of carrying sail, without the risk of upsetting. Stiffness, in ballasting, is occasioned by disposing a great quantity of heavy ballast, as lead or iron, in the hold, which naturally places the centre of gravity very near the keel; and that being the centre about which the vibrations are made, the lower it is placed, the more violent will be the motion of rolling. Crankness, on the other hand, is occasioned by having too little ballast, or by disposing the ship's lading so as to raise the centre of gravity too high, which also endangers the mast in carrying sail when it blows hard. For, when the masts are deflected from the perpendicular, they strain on the shrouds in the nature of a lever, which increases as the sine of their obliquity; and a ship that loses her masts is in great danger of being lost.

The whole art of ballasting, therefore, consists in placing the centre of gravity to correspond with the trim and shape of the vessel, so as neither to be too high nor too low, neither too far forwards nor too far aft; and to lade the ship so deep, that the surface of the water may rise nearly to the extreme breadth amidships, by which means she will be enabled to carry a good sail, incline but little, and ply well to the windward.

Ships are said to be in ballast when they have no other loading. Masters of vessels are obliged to declare the quantity of ballast they bear, and to unload it at certain places. They are prohibited unloading their ballast in

¹ Debes's *Description of the Islands and Inhabitants of Foeroe*, Englished by Dr Sterpin, p. 273. Lond. 1676, 12mo.

² Torfæi *Commentatio historica de Rebus gestis Færeysensium seu Færöensium*, p. 7. Havniæ, 1695, 8vo.

Ballenden havens, roadsteads, &c. the neglect of which prohibition has ruined many excellent ports.

BALLENDEN, SIR JOHN. See BELLENDEN, SIR JOHN.

BALLENSTEDT, a city in the duchy of Anhalt-Bernburg. It is situated in the Hartz Forest, in a most picturesque district, selected for a seat of the sovereign, whose castle is accommodated with the usual appendages of courtly residences. The city, besides the court, contains about 2800 inhabitants, who are very industrious in linen manufactures, and in gardening.

BALLET, BALET, or BALLETO, a kind of dramatic poem, representing some fabulous action or subject divided into several entries; wherein several persons appear, and recite things under the name of some deity, or other illustrious character.

BALLET also denotes a theatrical action, represented by dancing guided by music.

BALLINA, a post-town of Ireland, in the county of Mayo, situated on the river Moy. In 1798 General Humbert, who landed with the French troops in Ireland, took possession of this place. The population is 4422, and it is 6 miles S. of Killala.

BALLINAHINCH, a post-town of Ireland, in the county of Down, near which is a much-frequented chalybeate spa. In 1798 a strong body of insurgents were defeated here, and half the village was destroyed. The population is 884. Ballinahinch is 94 miles N. by E. from Dublin.

BALLINAKIL, a market-town of Ireland, in Queen's county, with woollen manufactures. The population is 1951, and it is 66 miles S. W. of Dublin.

BALLINASLOE, a thriving town of Ireland, in the county of Galway, on the river Suck. Here is held a great fair for wool, and several cattle fairs. The population is 1800. It is 90 miles W. of Dublin, and 30 miles W. of Galway.

BALLINGARRY, a post-town of Ireland, in the county of Limerick. The population is 1553. It is 142 miles S. W. of Dublin.

BALLINROBE, a post-town of Ireland, in the county of Mayo. Its population is 2191. It is 147 miles W. by N. from Dublin.

BALLISTA, a machine used by the ancients for shooting darts, and which resembled in some measure our cross-bow. The word is Latin, signifying a cross-bow, and is derived from the Greek *βαλλω*, to shoot or throw. Vegetius informs us that the ballista discharged darts with such rapidity and violence that nothing could resist their force; and Athenæus adds, that Agistratus made one of little more than two feet in length, which shot darts 500 paces.

BALLISTEUM, or BALLISTRÆA, in *Antiquity*, a military song or dance used on occasions of victory. Vopiscus has preserved the *ballisteum* sung in honour of Aurelian, who, in the Sarmatian war, was said to have killed forty-eight of the enemy in one day with his own hand. *Mille, mille, mille, mille, mille, mille decollavimus: Unus homo mille, mille, mille, mille decollavit; mille, mille, mille vivat, qui mille, mille occidit. Tantum vini habet nemo, quantum fudit sanguinis.* The same writer subjoins another popular song of the same kind: *Mille Francos, mille Sarmatas, semel occidimus; mille, mille, mille, mille, mille Persas quærimus.* It took the denomination *ballisteum* from the Greek *βαλλω*, *jacio*, or *jacto*, to cast or toss, on account of the motions used in this dance, which consisted in elevating, swinging, and throwing round the hands. The *ballisteæ* were a kind of popular ballads, composed by poets of the lower class, without much regard to the laws of metre.

BALLISTIC PENDULUM, an ingenious machine, invented by Benjamin Robins for ascertaining the velocity of military projectiles, and consequently the force of fired

gunpowder. It consists of a large block of wood, affixed to the end of a strong iron stem, having a cross steel axis at the other end, placed horizontally, about which the whole vibrates together like the pendulum of a clock. The machine being at rest, a piece of ordnance is pointed straight towards the wooden block or ball of this pendulum, and then discharged: in consequence of which the ball strikes, enters the block, and causes the pendulum to vibrate more or less according to the velocity of the projectile or the force of the blow; so that by observing the extent of the vibration, or the chord of the arc,—which is ascertained by means of a ribbon fixed to the lower extremity of the pendulum, and passed through a couple of steel edges something in the manner of a drawing pen,—the force of that blow becomes known, or the greatest velocity with which the block is moved out of its place, and consequently the velocity of the projectile which struck the blow and urged the pendulum. See GUNNERY.

BALLOON. See AERONAUTICS.

BALLOON also denotes a kind of game something resembling tennis. The balloon is played in the open field, with a great round ball of double leather blown up with wind, and thus driven to and fro with the strength of a man's arm, fortified with a brace of wood.

BALLOTING, a method of voting at elections, &c. by means of little balls, usually of different colours, called by the French *ballots*, which are put into a box, in such a manner as to enable the voter, if he chooses, to conceal for whom or for what he gives his suffrage.

BALLYBAY, a market and post-town of Ireland, in the county of Monaghan. Its population is 1378, and it is 76 miles N. by W. of Dublin.

BALLYCASTLE, a small sea-port town of Ireland, in the county of Antrim, divided into an upper and lower town. Its population is 1436, and it is 180 miles N. from Dublin.

BALLYMATRON, a market and post-town of Ireland, in the county of Longford. The population is 1135. It is 68 miles W. by N. of Dublin.

BALLYMENA, a town of Ireland, in the county of Antrim, situated on the river Maine. Linen manufactures are carried on here, and there is a weekly market for horses and cattle. The population is 2740. It is 30 miles N. of Belfast.

BALLYMONEY, a village of Ireland, in the county of Antrim, where there is a monthly market for linens. The population is 1949. It is 150 miles N. of Dublin.

BALLYMOTE, a post-town of Ireland, in the county of Sligo, where the linen manufacture has been established. The population is 884, and it is 119 miles N. W. from Dublin.

BALLYRAGGET, a post-town of Ireland, in the county of Kilkenny, on the river Nore. The population is 1604. It is 76 miles S. W. of Dublin.

BALLYSHANNON, a town of Ireland, in the county of Donegal, on a bay at the mouth of a river flowing from Lough Erne, which is crossed by a bridge of 14 arches. It has a good harbour, and a fishery of eels and salmon. The population is 3831. It is 127 miles N. W. from Dublin.

BALLYTORE, a post-town of Ireland, in the county of Kildare, on the river Grees. The population is 824. It is 35 miles S. W. of Dublin.

BALM OF GILEAD. The earliest specifics against personal injuries, resorted to by mankind, were probably the different parts of vegetables produced in their respective countries; and hence we find that most savages are acquainted with vulneraries prepared by the hand of nature, or that they seek to improve them from decoctions and infusions of roots, flowers, and leaves. Among the

Balloon
||
Balm of
Gilead.

Balm of
Gilead.

more precious substances obtained from plants, applied as curative of wounds by the ruder inhabitants of the eastern climates, the balm of Gilead, or balsam of Mecca, has been eminently distinguished during many ages. But although the balm of Gilead is well known from several scriptural allusions, and highly esteemed, it is only of secondary quality to the balsam of Mecca, for which it is frequently substituted; and illustrations of its nature and properties must chiefly be derived from the latter. This balsam is a resinous matter, exuding, like ordinary resin, from incisions in the bark of two different vegetables; at least there are apparently two, though the distinction is not well characterized or described by naturalists, which circumstance has excited conjectures that there is only one, and that it is subject to certain external modifications from soil and climate. The plant producing the balsam of Mecca was first ascertained by Forskal to belong to the genus *Amyris*. He transmitted one or two specimens to Linnæus, who has characterized it as the "*Amyris Opobalsamum*, leaves pinnate, with sessile leaflets, a native of Arabia;" while he characterizes the other as "*Amyris Gileadensis*, leaves ternate, very entire peduncles, one flowered lateral, a native of Abyssinia." We shall, however, consider it more in detail. This plant grows to the height of fourteen feet, flourishing in a hot climate, and in a stony barren soil. In general it is lower; and Mr Bruce describes a specimen five feet and a half in height, and five inches across the stem where thickest. The wood is white, light, and of open texture, covered with a smooth bark, reddish or bluish white, resembling that of a healthy standard cherry-tree, green within, and emitting a very fragrant odour; that of the branches, which are very flexible and resinous, being equally agreeable. The leaves, which are evergreen and scanty, bear some resemblance to those of rue; and the flowers, which are leguminous and of a purplish colour, resemble those of the acacia. The fruit consists of small pointed ovoidal berries, containing a yellowish fluid similar to honey, of a bitterish taste, and exhaling a pleasant perfume, approaching the odour of balm. This plant is called *Balessan* in the East; but it would require new botanical researches to ascertain definitely, and beyond dispute, whether it is of different species, as is most probable, and what is its real character;—points which we must consider as remaining to be established.

It has been maintained that the plants producing the balsam of Mecca are restricted to a plantation of little more than thirty acres in extent, at Beder Hunein, a station for pilgrims in Arabia, half-way between Mecca and Medina. Yet it cannot be positively affirmed that this is one distinct species; that Abyssinia, the country ascribed to the other, is deprived of it; or that the balm of Gilead grows exclusively in Abyssinia. These are facts which require elucidation from future botanical researches. The plantation belongs to a noble family of Arabs, of the tribe Beni Koreish, from which Mahommed originated, unless the incursions of the Wahabees, who interrupted the wonted pilgrimages, have dispossessed them.

The balsam in question flows from incisions in the tree, which are made with an axe, in July, August, and the beginning of September, when the circulation of the sap is in the greatest activity; and it is received into a small earthen bottle. Each day's produce is collected, and poured into one of larger dimensions; but the quantity obtained is very small, and its collection is tedious and troublesome; for the total exudation is usually but three or four drops in a day, nor does the most productive tree afford above sixty. Its scarcity, therefore, and the difficulty of procuring it, have no inconsiderable effect in enhancing its value. The odour is at first strong and pungent, occa-

sioning a sensation like that of volatile salts rashly inhaled. Its intensity is proportioned to its freshness and the care it receives; for if neglected and exposed to the influence of the air, the fragrance entirely decays. It is also of a rough, acrid, pungent taste. Originally the balsam is of a light yellow colour, somewhat turbid, and of a whitish cast, which is supposed to arise from the globules of air absorbed along with it; and it dissolves readily in water. It then acquires greater consistence, resembling honey, and becomes pellucid; and after the lapse of some years grows of deeper yellow, or gold colour, when it is very tenacious, and may be drawn out in threads. It is difficult, however, to obtain the balsam in a state of purity; for several different substances are employed in its adulteration, to detect which various experiments are resorted to. If dropped into a glass of clean water, it falls to the bottom without rising again to the surface; or if it remain still on the surface, like oil in a drop, it is certainly adulterated. If, on the contrary, it spreads on the surface of the water, diffusing itself in a thin pellicle, scarcely visible to the eye, and capable of being collected with a thread or a feather, it is the pure and natural product. In this state it will coagulate like milk, but not if otherwise. If pure it collects in a globule when dropped on hot iron; if adulterated, it runs and spreads itself all around. The different substances used in the adulteration of this balsam are honey, wax, oil of sesamum, turpentine, and ostrich fat. Sweetness of taste betrays the honey, and a turbid appearance the presence of wax. Adulteration with oil is detected by its yielding a darker and grosser flame than that which issues from the genuine balsam when dropped on burning coals. When the consistency becomes too great, which seems a consequence of age and long preservation, fluidity is restored by the simple application of heat.

Besides the balsam now described, which is the purest and most valuable kind, and is called *Opobalsamum*, other two of inferior quality are obtained from the *balessan*; first, *Carpobalsamum*, which is prepared by expression from the fruit when it has attained maturity, and which, if good, should be ponderous, of a pungent taste and balsamic odour; secondly, *Xylobalsamum*, which is elaborated from a decoction of the twigs. The latter are collected in small faggots and sent to Venice, and the circumstance which determines them to be the shoots of the year is said to consist in their being knotty, the bark red, and the wood white, resinous, and exhaling balsamic odour. Various impostures are likewise practised here, in substituting spurious compounds for the real drug; and the ingenuity of mankind in this species of deception has been carried to such an extent that detection proves extremely difficult.

Numerous virtues are ascribed to the balm of Gilead,—so numerous, that modern empirics, availing themselves of that credulity which characterizes our nature in all matters connected with health, do not hesitate to offer specifics of their own invention, under the same name, with bold asseverations that the human race will there find a palliative for most of the evils with which they are afflicted. Prosper Alpinus, one of the older naturalists, ascribes many properties to the balsam of Mecca, esteemed the most precious of all that bear the appellation of balsam, and in ordinary description considered as synonymous with the balm of Gilead; and the modern Arabs, Turks, and Egyptians, entertain great confidence in its efficacy. It is a powerful vulnerary, a quality of which Mahomet took advantage; for he affirmed that a grove of the trees sprung up from the blood of his own tribe killed in battle, the juice of which cured the wounds of the faithful, however deadly, nay, that it recovered some of them from death itself. Hasselquist says it is useful as a stomachic

Balm of
Gilead.

Balm of
Gilead.

in doses of three grains. It is also taken for complaints in the breast, and in fevers, and is applied for rheumatism. Its repute as an antiseptic is very great; and it is esteemed so effectual an antidote against the plague, that when this distemper makes its appearance the Egyptians take a certain quantity daily. The balsam of Mecca, however, is principally used as a cosmetic by the eastern females of rank. After being kept in a very warm bath, the face and breast are anointed with it; and the same process is continued every third day during a month. Oil of almonds and other cosmetics are then rubbed over the same parts, by which means the skin and complexion are beautifully renovated. Lady Mary Wortley Montague relates that she was induced to try the experiment; and that, in consequence, her face became swelled and red for three days, during which time she suffered so much pain as to restrain her from repeating the application. But her complexion was greatly improved; and she adds, that the ladies of Constantinople, by whom it is used, have the finest bloom imaginable.

The balm of Gilead has been celebrated from a very remote antiquity. We have the testimony of Moses that it was an article of commerce in the earlier periods of Jewish history; for at the time Joseph was confined by his brethren in a pit, and during their deliberations on his fate, it is said, "And they sat down to eat bread,—and they lifted up their eyes and looked, and behold a company of Ishmaelites came from Gilead, with their camels bearing spicery, and *balm*, and myrrh, going to carry it down to Egypt." Jeremiah particularly alludes to the virtues of the *balm in Gilead*. Josephus, however, does not carry the knowledge of it so high; for he observes, that the queen of Sheba or Saba, "who was inquisitive into philosophy, and on that and other accounts was also to be admired," brought the balm of Gilead as a present to Solomon, on her visit to Jerusalem, about a thousand years before the Christian era. "They say also that we possess the root of this balsam, which our country still bears, from that woman's gift." This is not inconsistent with the words of Jeremiah, who probably flourished about four thousand years later; and to reconcile the statement of Moses with this account, some critics have supposed that Judea did not possess the real balm of Gilead earlier than the queen of Sheba's gift, but an inferior kind of balsam;—a fact not improbable. Further, it appears, that what was in highest esteem as the balm of Gilead, was in truth the balsam of Mecca. The best testimony of its value is its having been the subject of royal donation among the rarities brought for the acceptance of so illustrious a prince as Solomon. It appears from the writings of the ancients who were contemporary with Josephus, that Judea was generally believed to be exclusively possessed of this product. Pliny remarks,—"but to all other odours whatsoever is to be preferred that balsam which is produced in no other part of the world than the land of Judea, and there in two gardens only, both belonging to the king, one not exceeding twenty acres in size, and the second still smaller." Strabo, however, in the opinion of Mr Bruce, ascertained the real spot where the balsam originated, in ascribing it to that country over or near to which the queen of Sheba reigned. "Near to this," he says, "is the most favoured land of the Sabæans, and they are a very great people. Frankincense, myrrh, and cinnamon, grow among them, and on the coast that is about Saba, the balsam also." Whence Mr Bruce observes, that "among the myrrh-trees behind Asab, all along the coast to the Straits of Babelmandel, is its native country. It grows to a tree above fourteen feet high spontaneously and without culture, like the myrrh, the coffee, and the frankincense tree; they are all

equally the wood of the country, and occasionally cut down for fuel." Diodorus Siculus likewise affirms that this balsam grew in a valley of Arabia Felix. But Mr Bruce, who investigated the subject with considerable care, supposes that it was towards the era of Pliny that it received its name of *Balsamum Judaicum*, or balm of Gilead, and thence became an article of commerce and fiscal revenue, which might probably operate as a discouragement to bringing it from Arabia; as also that it might be prohibited as contraband. Some centuries later than the time of those ancient authors, we see that it was known in Arabia, and perhaps in the place now most celebrated for it. A traveller who assumes the name of Ali Bey says that there is no balsam made at Mecca; that, on the contrary, it is very scarce, and is obtained principally in the territory of Medina; and also that it was called *belsan*. As the repute of the balsam of Mecca rose, the balm of Gilead disappeared; though in the era of Galen, who flourished in the second century, and travelled into Syria and Palestine purposely to obtain a knowledge of this substance, it grew in Jericho, and many other parts of the Holy Land. The cause of its total decay has been ascribed, not without reason, to the royal attention being withdrawn from it by the distractions of the country. In more recent times its naturalization seems to have been attempted in Egypt; for Prosper Alpinus relates, that forty plants were brought from Arabia by a governor of Cairo, to the garden there, and ten remained when Belon travelled in Egypt, nearly 250 years ago; but whether from not agreeing with the African soil or otherwise, only one existed in the last century, and now there appears to be none.

The balsam of Mecca has always been deemed a substance of the greatest value. When Selim, emperor of the Turks, reduced Arabia and Egypt under his dominion in the year 1516, he exacted a tribute of three pounds weight of it yearly; which continues to be sent to Constantinople to this day. Besides this, part of the governor of Cairo's appointments include a right to receive a pound of balsam; the like quantity was due to an officer who conducted the caravan of pilgrims to Mecca, and half a pound to the pasha of Damascus, who superintends the whole pilgrimage.

Notwithstanding the celebrity of this plant, Mr Bruce denies that it had ever been seen by the ancients, by whom he probably means the Romans, as their descriptions are so various and discordant. Prosper Alpinus, who lived in the sixteenth century, does not seem to know the real class to which it belongs; and even within these few years M. Duplessy, who has paid much attention to the exudations of vegetables, is apparently not aware of its having been figured by Bruce, and also more recently by Dr Woodville. Such uncertainties of old excited a violent dispute between the inhabitants of Rome and Venice whether the drug used in medicinal compounds was truly the balm of Gilead; and the point being referred to the pope, his holiness directed that information should be obtained from Egypt, in consequence of which he decided in favour of the Venetians.

The balsam of Mecca is not the only one possessing exclusive medicinal properties, though it is, perhaps, more eminently distinguished for them. Sixteen balsamic plants of the same genus are enumerated by botanists, each exhibiting some peculiarity; and the balsam of Tolu, obtained from incisions on a shrub growing in some of the South American provinces, is thought to approach the nearest to the virtues of this famous balm. It is highly aromatic, a powerful antiseptic, and not less efficacious as a vulnerary. It is also very rare and difficult to be procured, which has induced impostors to offer adulterations

Balm of
Gilead.

Balmerino or counterfeits under its name. That which is particularly substituted is the balsam of Peru, the product of another tree, which can be obtained in abundance either from incisions or decoction of the different parts. The secretions of these plants, however, are neither invariably odoriferous nor salutary: the balsam of Carthagenæ exhales a penetrating disagreeable smell; and there is a low evergreen shrub, a native of North Carolina and the Bahama Islands, producing a fruit which is deadly poison, and a balsam as black as ink.

BALMERINO, a village and parish of Scotland, in the county of Fife, situated on the Tay, where are the ruins of an abbey founded by Alexander II. in 1229. The population is 921. It is about 8 miles north-west of St Andrews.

BALNAVES, HENRY, a Scottish protestant, born in the shire of Fife in the reign of James V., and educated at the university of St Andrews. He went afterwards to France in order to finish his studies, and returning to Scotland, was admitted into the family of the earl of Arran, who at that time governed the kingdom; but, in the year 1542, the earl dismissed him for having embraced the protestant religion. In 1564 he joined (says Mackenzie) the murderers of Cardinal Beaton; for which he was declared a traitor, and excommunicated. Whilst that party were besieged in the castle of St Andrews, they sent Balnaves to England, who returned with a considerable supply of money and provisions; but being at last obliged to surrender to the French, he was sent with the rest of the garrison a prisoner to France. During his confinement at Rouen he wrote the work entitled *Confession of Faith*; but it was not published till 1584, five years after his death. He returned to Scotland about the year 1559, and having joined the Congregation, was appointed one of the commissioners to treat with the duke of Norfolk on the part of Queen Elizabeth. In 1563 he was made one of the Lords of Session, and appointed by the General Assembly, with other learned men, to revise the *Book of Discipline*. Knox, his contemporary and fellow-labourer, gives him the character of a very learned and pious man. Balnaves died at Edinburgh in the year 1579.

BALNEarii SERVI, in *Antiquity*, servants or attendants belonging to the baths. Some were appointed to heat them, called *fornicatores*; others were denominated *capsarii*, who kept the clothes of those that went into them; others *aliptæ*, whose care it was to pull off the hair; others *unctuarii*, who anointed and perfumed the body.

BALNEARIUS FUR, in *Antiquity*, a kind of thief who practised stealing the clothes of persons in the baths; sometimes also called *fur balnearum*. The crime of those thieves was a kind of sacrilege, for the hot baths were accounted sacred; and hence they were more severely punished than common thieves, who stole out of private houses. The latter were usually acquitted on paying double the value of the thing stolen; but the former were generally punished with death.

BALOGNES, an arrondissement in the department of Manche, or of the Channel, in France, extending over 325 square miles, and comprehending seven cantons and 122 communes, with 94,676 inhabitants. The capital is a city of the same name, on the river Merderet. It contains 1050 houses, and 7112 inhabitants, employed chiefly in making woollen and linen goods, and gloves. Near it have been discovered some Roman antiquities, especially the ruins of an amphitheatre. Long. 1. 34. W. Lat. 49. 30. N.

BALOTADE, a term in the *manège*, signifying a leap made by a horse between two pillars, or upon a straight line, in such a manner that when his fore feet are in the

air, he shows nothing but the shoes of his hinder feet without jerking out.

BALSOVER, or BOLSOVER, a market-town in the hundred of Scarsdale and county of Derby, 155 miles from London. It is celebrated for the manufacture of tobacco pipes, and for an ancient magnificent castle built by the family of Hastings, earls of Abergavenny. The number of inhabitants in 1801 amounted to 1091, in 1811 to 1151, and in 1821 to 1245. The market is held on Friday.

BALTA, a town, the capital of the circle of the same name, in the Russian government of Podolia. It stands on the Kodima, near its junction with the Bug, and carries on a trade in corn by that river with Warsaw and Dantzic. The population is 1600. Long. 29. 33. E. Lat. 47. 46. N.

BALTIC SEA. The denomination of the Baltic, applied to the inland sea which forms the subject of this article, is first found in the work of Adam of Bremen, who was canon of that city at the close of the eleventh century, entitled *Chorographia Scandinaviae*. The etymology of this name has given rise to many conjectures. The Swedes derive it from the Scandinavian word *baelt*, a girdle, because its waters encircle the land; the Prussians, from the Sclavonian or Lettonian word *balt*, white, from its being frozen part of the year, or from *Baltus*, one of their kings; while by others it is derived from *Balteia*, the name of an island mentioned by Pytheas, a merchant of Marseilles, who, in the second or third century before the Christian era, is supposed to have sailed as far north as this sea. In the countries which bound it, its ancient name was *Variatzkoiè Morè*, or the Sea of Variaghi; by the modern Russians it is called *Baltiskoiè Morè*; and by the Swedes, Danes, and Germans, the *East Sea*.

I. The Baltic is entered from the British or Northern General Ocean by the Skager-Rack, Cattegat, Sound, and Great and Little Belts. The Skager-Rack extends from the Naze of Norway and the north-west point of Jutland, to the Gulf of Gottenburg and north point of Jutland, or Scagen Point, better known to English seamen by the name of the Scaw. The narrowest part of the Skager-Rack is 19 leagues. The Cattegat extends from Gottenburg and the Scagen Point to the Sound and Belts. The greatest depth of the Cattegat is 35 fathoms; but it decreases as it approaches the Sound. The Sound is the channel between the coast of Sweden and the island of Zealand. A mass of rocks on the Swedish shore distinguishes its entrance from the Cattegat; its termination is between Falsterbo in Sweden and Cape Stevens in Zealand. Its narrowest part is between Elsinour and Helsingborg, where, measured on the ice, it is 2840 yards. Between Copenhagen and Landscrona it is between six and seven leagues across. Its greatest depth, where narrowest, is 19 fathoms. Towards the Danish shore, at the entrance of the Sound from the Cattegat, its depth is 16 fathoms; but near Copenhagen it is not more than four fathoms. Close to the Swedish shore there is a gradual accumulation of sand. The Great Belt, between the islands of Zealand and Funen, is between seven and eight leagues wide at its broadest place, between Corsør in Zealand, and Nyborg in Funen. The little island Sprogø lies nearly in the middle of it. The coasts are in general low and sandy; and the greatest depth is about 22 fathoms. The Little Belt, between Funen and the coast of Jutland, is in its greatest breadth about seven miles, and, where narrowest, about three quarters of a mile. In general the shores are little elevated. Its greatest depth is 27 fathoms.

The Baltic extends 240 leagues from Torneo to the Island of Wollin, on the coast of Pomerania. Its northern extremity is situate in the latitude of 65° 51', and its southern extremity is in 53° 30'. It runs first in an easterly direction as far as Memel, a length of 300 miles, with a mean breadth

Balsover
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Baltic.

General
Ocean by the Skager-Rack, Cattegat, Sound, and Great and Little Belts. The Skager-Rack extends from the Naze of Norway and the north-west point of Jutland, to the Gulf of Gottenburg and north point of Jutland, or Scagen Point, better known to English seamen by the name of the Scaw. The narrowest part of the Skager-Rack is 19 leagues. The Cattegat extends from Gottenburg and the Scagen Point to the Sound and Belts. The greatest depth of the Cattegat is 35 fathoms; but it decreases as it approaches the Sound. The Sound is the channel between the coast of Sweden and the island of Zealand. A mass of rocks on the Swedish shore distinguishes its entrance from the Cattegat; its termination is between Falsterbo in Sweden and Cape Stevens in Zealand. Its narrowest part is between Elsinour and Helsingborg, where, measured on the ice, it is 2840 yards. Between Copenhagen and Landscrona it is between six and seven leagues across. Its greatest depth, where narrowest, is 19 fathoms. Towards the Danish shore, at the entrance of the Sound from the Cattegat, its depth is 16 fathoms; but near Copenhagen it is not more than four fathoms. Close to the Swedish shore there is a gradual accumulation of sand. The Great Belt, between the islands of Zealand and Funen, is between seven and eight leagues wide at its broadest place, between Corsør in Zealand, and Nyborg in Funen. The little island Sprogø lies nearly in the middle of it. The coasts are in general low and sandy; and the greatest depth is about 22 fathoms. The Little Belt, between Funen and the coast of Jutland, is in its greatest breadth about seven miles, and, where narrowest, about three quarters of a mile. In general the shores are little elevated. Its greatest depth is 27 fathoms.

Extent of
the Baltic.

Baltic. of 140. It then sweeps northwards to the Aland Isles, a length of 350 miles, with a mean breadth of 70. Its northern portion forms the Gulf of Bothnia, which is 150 leagues in length, with an extreme breadth of 162 miles. The archipelago of Aland lies at its entrance from the Baltic, and forms three channels between the coast of Sweden and the islands composing the archipelago. The breadth of the channel is between eight and nine leagues. This is called the Sea of Aland by the Swedes. The space between Aland and the coast of Finland is filled with numerous islands, among which are two channels. The lower part of the gulf from Aland to Umeo is called by the Swedes the Sea of Bothnia. Between Umeo and Wasa the channel is narrowed by a number of rocky islands, forming a strait eight or nine leagues wide, from which the gulf widens very considerably, and to its head is called by the Swedes the Gulf of Bothnia. Its greatest ascertained depth is 50 fathoms. On the east the Baltic forms the Gulf of Finland, which is 80 leagues long and from 11 to 22 broad. Its entrance is between Spinthamer Point in Esthonia, and Hangoe Head in Finland. Its greatest depth is 60 fathoms, which, in some places, decreases to five fathoms. A vast number of rocky islands and reefs, many of them level with the water, renders the navigation of this sea extremely dangerous.

Depth of the Baltic. The general depth of the Baltic is 60 fathoms; but towards its south-east extremity, and nearly in the middle, are two spots, with 110 and 115 fathoms of water. From the east mouth of the Sound to Bornholm, the depth varies from 9 to 30 fathoms; from thence to Stockholm it is from 15 to 50; a little south of Lindo it is 60; and among the Aland Islands it is from 60 to 110.

Level of its waters. It was long a generally received opinion that the waters of the Baltic were considerably more elevated than those of the German Ocean, and that they were gradually diminishing. This seems to have rested entirely on the fact of a constant current setting out of the Baltic; and to this it is ascribed by Vice-Admiral Nordenancker, who was president of the Swedish Academy in 1792. In a paper published in their *Transactions*, he maintains that, from observations made at different periods, the height of the waters of the Baltic was diminishing at the rate of about four and a half lines annually. Celsius, a learned Swede, who flourished towards the middle of last century, advances the same hypothesis; and, from observations made on the coasts of the Baltic, he estimated the diminution at 45 inches in every hundred years. This hypothesis was supported by Linnæus, who founded on it a theory of the earth; but the chief facts brought forward in support of it, namely, marks on several rocks in the Gulf of Bothnia, and the remains of vessels found at considerable distances from the present shores, by no means warrant it. M. Otto, in his physical observations on this sea, has suggested another theory to account for its apparent decrease. He supposes that, instead of really subsiding, it may be only shifting its position, and gaining in one quarter what it loses in another; and this he ascribes to the large and rapid rivers, which carry along with them an immense quantity of earth and sand, by which the beds at their mouths are raised, and their banks extended towards the sea. But recent observations, made at the locks of the canal of Holstein, prove that the levels of the Baltic and the ocean are at present generally the same; and that the trifling differences which may be occasionally observed are owing to accidental and temporary causes. Hence we may infer that the constant current setting out of the Baltic is solely owing to the abundance of the waters which it receives from its rivers.

Tides. It is generally believed that there are no tides in the Baltic. This, however, is not strictly correct. There are

sensible tides in the Skager-Rack; but these begin to diminish in the Cattegat, are very trifling in the Sound and Belts, and in the Baltic, properly so called, are scarcely, if at all, perceptible. There are, however, irregular variations in the level of the waters of the Baltic, which bear some resemblance to tides. These elevations generally occur in autumn, when the weather threatens rain; and they last sometimes a few days, sometimes several weeks. The maximum rise is three feet and a half, and the low shores are occasionally inundated. They also render the fresh-water lakes which communicate with the sea brackish. In the Gulf of Bothnia, the fall of the waters is usually succeeded by north winds; whereas, near Stockholm, these winds usually follow the elevation. M. Kraft, formerly professor of experimental philosophy in the Imperial Academy of Sciences at Petersburg, in his treatise on the inundations of the Neva at the autumnal equinox, observes, that three or four days before or after the full or new moon, a violent north-west wind drives the waters of the Northern Ocean, during the influx of the tide, into the Baltic, and is accompanied or immediately succeeded by a south wind in that sea and the Gulf of Finland. By Schultens, a learned Swede, who paid particular attention to the physical geography of the Baltic, the irregular elevations of this sea are attributed to the state of the atmosphere. He had observed that when the waters were about to rise the barometer fell, and that when they were about to fall it rose. Hence he inferred that the unequal pressure of the atmosphere on different portions of the water deranged the level of the waters. The difference between the greatest and the least rise of the barometer in the northern parts of Europe is two and a half inches, which answers to three and a half feet of water, or the difference of the elevation of the waters at their extremes.

In the Sound there are superior and inferior currents. These were first observed by some Englishmen, who, being in a boat in the middle of the channel, found that they drifted towards the Cattegat; but having let down a loaded bucket to the depth of four or five fathoms, the boat became stationary; and when the bucket was sunk deeper, the boat drifted against the superficial current. The general currents of the Baltic are strong, and evidently occasioned by the vast number of rivers and streams that pour their waters into it, many of which, especially towards the north, rise thrice in the course of the year. At the northern extremity of the island of Bornholm, a violent agitation of the waters, or kind of whirlpool, called by the Swedes *malt-quern*, or the grinding-mill, is occasioned by the current rushing over a circular cluster of sunken rocks. The waves of the Baltic are short and broken, in consequence of sudden changes of wind, irregular depths, and strong currents.

The waters of this sea are not nearly so salt as those of the ocean; and when the wind blows strong from the north, they become so fresh as to be fit for drinking or cooking meat. The degree of their saltiness varies in different parts, and even in the same parts, according to the season or wind. According to Bergman, in his *Physical Geography*, the waters near the south coast of Norway, at the entrance of the Skager-Rack, contain from $\frac{1}{10}$ th to $\frac{1}{12}$ th part of their weight of salt; in the Cattegat $\frac{1}{12}$ th; in the Baltic $\frac{1}{16}$ th; and in the Gulf of Bothnia from $\frac{1}{30}$ th to $\frac{1}{40}$ th. The south-west and west winds augment the saltiness, by introducing the waters of the ocean. In the summer it requires 300 tons of the water of the Gulf of Bothnia to produce one ton of salt, but in the winter only 50 tons. This difference is caused by congelation, and by less fresh water flowing into it.

The analysis of three pounds of water taken up from

Baltic.

Baltic. the British Sea, on the coast of East Friezland, and the same quantity from near Rostock in the Baltic, gave

Analysis of
its waters.

	British Sea.	Baltic.
Muriat of soda.....	522	263
Muriat of magnesia.....	198½	111
Sulphat of lime.....	23	12
Sulphat of soda.....	1½	1
Residue.....	1½	1
	746½	388

The following are the results of some experiments made by Dr Thomson on the specific gravity of the water in the Frith of Forth, the Baltic off Tunaberg, the Sound, and off the Scaw Point; and also on the comparative weight of salt obtained from 1000 grains of each of the waters evaporated.

	Specific gravity.	Weight of Salt.
Water of the Frith of Forth.....	1.02900	36.6
Baltic off Tunaberg.....	1.00476	7.4
Sound.....	1.00701	11.2
Scaw.....	1.02037	32.0

In the salt obtained from the water off the Scaw, he found

Muriat of soda.....	55.7
Sulphat of magnesia.....	25.
Muriat of magnesia.....	19.3

100

Wilcke ascertained that the specific gravity of the water of the Baltic was much influenced by the wind. When the wind was at east it was.....1.0039

West.....	1.0067
North-west.....	1.0098
Storm at west.....	1.0118

Tempera-
ture.

There is great difference in the temperature in different parts of the Baltic. The general temperature of the Gulf of Bothnia in July is from 48° to 56°, but it is sometimes heated to 70°; the medium of the thermometer throughout the year at Uleoborg is 29°, and at Stockholm 42½°. Near the land in the Gulf of Bothnia, the temperature of the atmosphere in the month of July was observed to be 68°, while the temperature of the surface of the water was 65°; and in October the temperatures of both were respectively 39° and 46°. In the Sound, the temperature of the atmosphere in the month of August was 70°; on the surface of the water 68°; and at three fathoms 66°. On the 10th of October 1813 Dr Thomson found the temperature of the Sound to be 54°. The Skager-Rack and Gulf of Norway are open to navigation all the winter, whereas several portions of the Baltic are covered with ice in a very moderate degree of cold; and generally the bays and channels are encumbered with ice at the latter end of December. The waters towards the heads of the Gulfs of Bothnia and Finland are first frozen; and the ice being conveyed by the currents to the south, the masses of it are, by the increasing cold, united into vast fields, which become stationary on the west towards Stockholm, and in the east towards the islands of Dagœ and CEsel. In the southern parts of the sea the ice begins to break up in April, but the Gulfs of Bothnia and Finland often continue closed till May. The rigour of the climate in the Baltic is supposed to be considerably diminished by the clearing of the forests and the progress of cultivation; at least more intense and long-continued colds, as well as

greater extent and solidity of ice, are recorded during the fourteenth and fifteenth centuries, than what have happened latterly.

The winds are extremely variable in the Baltic, but they blow most commonly from the east in the spring, and from the west in autumn; calms are seldom experienced, except in the middle of summer.

II. There is historical evidence that the herring fishery was a branch of national industry in the Sound as early as the year 1168;¹ and in 1389 Philip de Mezières says that such vast shoals of herrings crowded into the Sound, that 40,000 boats, with from six to ten men each, were employed in the fishery, besides 900 large vessels, in which the herrings were salted. In the Gulfs of Flensburg and Slie, besides what are consumed fresh, about 1000 tons salted are annually exported to Copenhagen and Germany; and, according to the registers of the custom-house at Dalborg, on the south shore of the Gulf of Limfiord, this city exported yearly, from 1720 to 1730, above 23,000 tons, but from 1754 to 1765 the exportation had fallen to about 8000 tons. In the year 1748 the herring first appeared in shoals in the Gulf of Gottenburg; at first they arrived in August and September, but gradually later, and at present not till November or December. In 1752, there were 1000 tons taken; in 1753, 2000 tons; in 1761, 100,000 tons: from 1790 to 1796, nearly 2,000,000 tons were salted, and it was estimated that from 50,000 to 100,000 tons were consumed fresh.

Pilchards abound in the Gulfs of Bothnia and Finland, into the bays of which they arrive in shoals in spring and autumn. The pilchard fishery is one of the most important branches of industry to the inhabitants on both sides of the Gulf of Bothnia. As soon as the ice breaks up, upwards of 200 families, with their children and servants, transport themselves to the rocks and islets that line the coast, where they remain fishing till the end of autumn. The annual produce of all the pilchard fisheries is estimated at 300,000 tons at least, which are entirely consumed in the Baltic.

Salmon ascend the rivers from April to June, according as they are free from ice. On the south they abound most in the Oder, Vistula, Düna, and Narrova; on the north, in the Motala, Dalecarlia, Uleo, Kemi, Torneo, and Keymen. Salmon trout is taken in some bays of the Baltic. In the middle of the river Kemi is a small island, where an annual salmon fair is held. The salmon fisheries of Sweden are very considerable, both in the Cattegat and the Gulf of Bothnia: from 20,000 to 25,000 tons are salted annually.

Whales very rarely enter the Baltic. The common porpoise is the only one of the lesser species of cetaceous animals that lives habitually in this sea; and at Middlefart, in Funen, is a company, which enjoys the exclusive privilege of taking it. There are two varieties of the common seal, both of which are hunted for their oil in March and April, by the peasants of the isle of Gottland, and of the islands in the Gulfs of Bothnia and Finland.

III. The coast of the Baltic, including under that appellation the Skager-Rack, the Cattegat, the Sound, and the Belts, as well as Baltic Proper, may be regarded as commencing on the north side at the Naze of Norway. This is the extremity of a rocky peninsula joined to the main by a narrow isthmus; it is surrounded by rocks, of which those named the Bishop and Clerks, five miles to the south of the Naze, are most dangerous to navigators.

¹ "In the year 1238 the inhabitants of Gothia (Sweden) and Frise were prevented, by their fear of the Tartars, from sending, as usual, their ships to the herring fishing on the coast of England; and as there was no exportation, 40 or 50 of these fish were sold for a shilling. (Matthew Paris, p. 396.) It is whimsical enough that the orders of Mogul Khan, who reigned on the borders of China, should have lowered the price of herrings in the English market." (Gibbon's *Roman Empire*, vol. xi. p. 422.)

Baltic. From the Naze to the east, the shore is formed of elevated barren and dreary rocks. The principal rivers of Norway which fall into the Skager-Rack and Cattegat are the Glommen, the Laugen, the Louen, the Drammen, the Mandal, and the Nid. At the distance of five miles from the Naze is the town of Mandal, situated on the river of that name: from this place is exported a considerable quantity of smoked and salted salmon, esteemed the best in Norway. About 15 miles to the east of this is Christiansand, which has a good roadstead, besides the advantage of the little river Torvedal, to the east of the town; it exports timber, salt, fish, and iron. Next comes Arendal, the most secure and capacious harbour in Norway, formed by the Sound between the Island of Fleckerøe and the Main. On the river Louen is the town of Laurvig, which exports a great deal of iron from the foundries in its neighbourhood. The Gulf of Christiana lies some leagues to the east of it. This gulf runs up into the land 20 leagues, and divides into several branches: the entrance to it is indicated by the island of Færdar, on which there is a light. The town of Christiana stands at the top of the gulf: its port admits the largest vessels, there being from 30 to 40 feet water close to the quay; and its exports, which consist of fir planks and rafters, pitch, tar, soap, iron, copper, and alum, generally amount to L.100,000 annually, the timber constituting four fifths. There are several little villages on the gulf, where vessels load with timber. To the east of it is a deep inlet, called Swinesund, which separates Norway and Sweden; it consists of two basins, the outer of which communicates with the inner by a very narrow strait. On the inner basin, and at the mouth of a small river, is Fredericshall, the commerce of which consists principally in the export of planks, sawed by thirty-six mills on the river.

The Swedish shores of the Skager-Rack and Cattegat are high, with a most rugged and dreary appearance, particularly near Marstrand, where the shore is lined with steep rocks projecting into the sea. The coast of Schonen forms a striking contrast to the shores of the Skager-Rack and Cattegat, being nearly level and free from rocks. The Swedish coast from Bleskingar to the Gulf of Bothnia is lined with islands and rocks, and broken into a great number of gulfs and bays. Both shores of the Gulf of Bothnia are rugged and broken; that of Sweden, in particular, forms a sort of alpine ridge. The first river in Sweden, towards its western limit, is the Gotha, which flows into the Cattegat by two branches surrounding the island of Hysingen. This river, and the Motala, which falls into the Bay of Browick at Nordköeping, are the only rivers of consequence in the southern provinces of Sweden. Between the provinces of Södermanland and Upland is the lake Mælar, which communicates with the Baltic at Stockholm by two currents called the north and south; its elevation is six feet above the level of the Baltic. The river Dahl, or great river of Dalecarlia, the Umeo, Torneo, and several others, which rise in the mountains of Lapland and Norway, fall into the Gulf of Bothnia: the northernmost are subject to three inundations annually; the first in March or April, when the snow on the low ground melts; the second towards the end of May, when the snow melts on the more elevated grounds; and the last towards the end of summer, when the thaw has reached the high lands and dissolved the glaciers. The first commercial port of Sweden of any note is Uddevalla, a staple town; its exports are iron, planks, and herrings. The town of Marstrand, on an island of the same name, succeeds: it is also a staple place, and its inhabitants are engaged in the herring-fishery, and in supplying provisions to the vessels which run in for shelter, and which exceed 300 annually. The Paternosters are dangerous rocks some

miles north of Marstrand. On the southern branch of the Gotha, some leagues from the sea, is the city of Gottenburg; the port is seldom closed by the ice, and is capable of receiving the largest ships; the harbour is about one fourth of a mile in breadth, and is formed by two chains of rocks.

Before the entrance of the Gotha is the island of Wingø, with a very high light-house. The south point of the Bay of Skelder is formed of a mass of rocks lying at the entrance of the Sound, named Kullen; this mass projects far into the sea, and on the highest point, 200 feet above the sea, is a fire-tower. On the Swedish shore of the Sound are several villages of little consequence. Helsingborg, which is the usual place from which people cross to Elsinour, is the only one deserving of notice. Four leagues to the southward is Landscrona, a small and ill-sheltered port, with 20 feet water; it is a staple town. The next port is Malmoe, which has a considerable trade, although its harbour is not capable of receiving vessels of any great burden. To the south are Skanor and Falsterbo, on the peninsular point which forms the entrance of the Sound from the Baltic. Close to the latter is a fire-tower, to direct vessels clear of a large reef which runs off from the point. The first Swedish ports on the Baltic of any consequence are Christianstadt and Carlshamn. The former is situated on the Helge, which falls into a gulf that separates the provinces of Schonen and Bleckingen; the latter has 40 trading vessels engaged in foreign voyages. The principal export of Carlshamn is potash, which is esteemed of superior quality. They are both staple towns. The principal part of the town of Carlscrona is built on the island of Trosø, the rest of it on several rocky islets joined to the main by bridges. It is a staple town, and has about 40 vessels employed in foreign trade: the port is capable of admitting 100 sail of the line: on one of the islands is a dock for four sail of the line. Carlscrona is the principal station of the Swedish navy. The Strait of Calmar, which is from two to three leagues broad, separates the mainland from the island of Öland. Near the middle of the strait stands the town of Calmar, which, though not a staple place, has a considerable trade, and vessels from 100 to 300 tons, belonging to it. North of Calmar are several small towns on the coast, one of which, Westerwic, has some ship-building. In East Gothland, the province which lies to the north of Smaland on the Baltic, are two considerable gulfs, Slætbacken and Browick. On the river Motala, which falls into the latter, stands the staple town of Nordköeping, from which are exported considerable quantities of iron, iron cannon, and copper, though its port can only receive vessels of light burden. From 300 to 400 enter it annually; and 30 or 40 trading vessels belong to it. North of the entrance of a sound which communicates with Lake Mælar by a canal, is Landsort Island, where there is a light, and whence ships take pilots for Stockholm.

Stockholm is built on seven or eight islands and peninsulas, at the entrance of Lake Mælar: the channel is 12 leagues in length, very winding, and terminates in a basin capable of holding 1000 ships. The largest island, on which the city stands, forms two channels, through which the waters of the lake rush out with great impetuosity.

The only ports of any consequence in the province of Upland, are Grislehamn, opposite the islands of Åland, where travellers embark or take sledge for Åbo; and Öregrund, on an island in the channel of Åland, from which the iron from the foundries of Danemora is exported. Formerly it was sent chiefly to England, where it was converted into steel. From Gefle, a staple town on both sides of a river of the same name, are exported considerable quantities of iron, planks, tar, and potash; its imports are

Baltic.

Baltic. corn and salt. The smaller islands in the Baltic belonging to Sweden have already been noticed. Besides these there are Huen, Oeland, and Gottland. Huen lies in the Sound, four miles from Landskrona, three from the nearest point of Sweden, and four from the nearest point of Zealand: it is about six miles in circumference. Oeland is separated from the coast of East Gothland by the Strait of Calmar: the east coast of the island is bold and clear, but the west is dangerous for mariners. Between Oeland and a group of rocks is the southern channel into the Strait of Calmar. Nearly in the middle of the strait is a rock, almost perpendicular, 240 feet high, surrounded by reefs. Gottland, which is 18 leagues from the nearest point of Sweden, and about the same distance from Courland, is 20 leagues in length, and seven at its greatest breadth. Its shore in some places is nearly perpendicular, in other places it ascends gradually. Wisby, the capital, is built on the west coast; at present its port is capable of receiving only a few small vessels. Slitehamn, on the east of the island, is one of the best ports in the Baltic, and is defended by the fort of Carlsbelt.

The coasts, rivers, gulfs, and principal commercial ports of the south and east of the Baltic, are next to be described; and, beginning at the entrance from the German Ocean, those of Denmark first present themselves. The north point of Jutland, in the Scaw, is surrounded by a reef several leagues in extent, and on its extremity is a light-house, 64 feet above the level of the sea. The north and east coasts of this peninsula are generally low; the northern extremity is composed of sands, which are often conveyed by whirlwinds to a great distance, and do considerable damage. In order to fix them, a variety of plants, particularly the *Elymus arenarius*, sea lime-grass, are sown. The east coasts of Sleswick and Holstein descend gently to the sea. On all these coasts there are numerous gulfs and bays; the first towards the north is the Limfiord, which nearly divides the peninsula of Jutland, being separated from the German Ocean only by a sandy isthmus three or four miles broad; another arm of it advances southward to the town of Wyborg, a length of about 80 or 90 miles; its entrance is two miles wide, but afterwards it becomes greatly wider; sands that very sensibly increase, and masses of granite, obstruct its entrance. In Jutland there are also the Gulfs of Mariager and Randers, and several bays. In Sleswick, on the Baltic side, are the Gulfs of Colding, Flensborg, Slie, which resembles a great river, and Ekernefiord; in Holstein are the Gulfs of Kiel, which separates this province from Sleswick, and of Lubec, and the Bay of Colberg. The Guden is the chief river in Jutland, which falls into the Baltic, at the Gulf of Randers, after a course of 40 miles.

Ports. From the Scaw to the entrance of the Gulf of Limfiord there are only small towns, chiefly inhabited by fishermen and pilots. On the north shore of the entrance of Limfiord is the fort of Hals, where vessels of too great depth to ascend higher discharge their cargoes; and on the south shore, four leagues and a half from the sea, is Aalborg, the chief town of Jutland. It possesses considerable commerce, its exports consisting of corn, cattle, and fish; and it has 60 or 70 trading vessels belonging to it. Frederica, which stands on a promontory at the entrance of the Little Belt, has an inconvenient and badly-sheltered port: the merchant-vessels passing through the Little Belt pay toll here. Colding, at the head of the gulf of the same name, which separates Jutland and Sleswick, is a commercial town, and has a port of two miles in circuit, and of depth sufficient for the largest vessels. The trade of Sleswick, which stands at the head of the Gulf of Slie, has much declined: the entrance to its port being filled up with sand, a canal has been cut into it.

Of the Danish islands, Zealand is the principal; its length is 24 leagues, its breadth varies from 20 to 14; the Gulf of Isefiord, divided into two branches, penetrates the north side of it, at the entrance to which there is only nine feet water, but it deepens within to seven fathoms. The most remarkable river in Zealand is the Nesaa, which nearly traverses it, and enters the Baltic. Elsinour, on the narrowest part of the Sound, has only a roadstead: here the duties of the Sound are paid. The origin of these duties may be traced to the middle ages, when they were established by the sovereigns of Denmark for the support of light-houses and the protection of the navigation of the Baltic from pirates. These duties vary from 450,000 to 600,000 rix-dollars annually. The mails and passage-boats cross the Sound from Elsinour to Helsingborg.

Copenhagen is built partly on the mainland, and partly on the island of Amak, which is separated from it by a narrow channel, crossed by two bridges. The port between Amak and the main is one of the best in the Baltic, both by nature and art. Within are basins capable of containing 500 sail, but the entrance admits but one ship at a time. There are two royal dock-yards constructed on islands, where every ship has her particular magazine: the dry-dock is constructed of wood, and requires 20 hours to pump it dry, which is done by horses. Copenhagen is a free port, and for a long time was the only one in Denmark which enjoyed the privilege of importing the produce of Iceland, Greenland, India, China, and America; and, even yet, the principal returns from these countries are made to it.

Mæen island is separated from the south-east end of Zealand by Ulsund, a narrow strait. It is about five leagues long and from one to three broad. It exports 15,000 tons of corn. Samsø, midway between Zealand and Jutland, is near five leagues long, and is formed of two peninsulas, the largest of which is five miles broad. The other islands belonging to the government of Zealand are of little consequence. Saltholm, in the Sound, may however be particularized; it is four miles long and two broad; almost covered by the sea in winter, but in summer affords good pasturage, and from it are exported to the capital, marble, freestone, and lime.

Funen, the second of the Danish islands in extent, is 16 leagues long and 11 broad. The Gulf of Odenzee runs considerably into it on the north-east. At the head of the gulf stands the town of Odenzee, the capital. From twenty to thirty trading vessels belong to it. At Nyborg, on the Great Belt, a duty is paid by all merchant-vessels passing through; it is also the usual crossing place to Zealand, and has a good port, with about as many vessels belonging to it as Odenzee. The island of Funen exports corn; and in the year 1799 there belonged to it fifty-seven vessels above 20 tons, amounting to 2522 tons, with 109 men. From Rudkøping, the only town on Langland, an island between Funen and Zealand, corn, salted meat, hides, honey, and wax are exported.

Laaland, the third of the Danish islands in size, is 11 leagues long and from six to eight broad. Considerable portions of its coast are so low as to be inundated during the irregular elevations of the sea. The feathers of aquatic birds and corn are its principal exports. From this island Falster is separated by Guldborg Sound, and from Mæen by Grensund. It is eight leagues long and from one to four broad. It exports corn and fruit. In the year 1799 there were in the bailiwick of Laaland and Falster fourteen vessels, of 460 tons and 40 men. In the government of Jutland are the islands of Lessø and Anholt, in the Cattegat; the latter is surrounded by dangerous banks.

Bornholm is an island about seven leagues and a half from the coast of Sweden, and upwards of 17 from the

Baltic.

Baltic. island of Rugen. It is eight leagues long and five and a half broad. Its shores are composed of steep rocks, surrounded by dangerous reefs. The principal imports are coffee, sugar, and tobacco; the principal exports are salted cod, corn, poultry, clay for the porcelain manufactory of Copenhagen, and freestone for its public buildings. The centre of commerce is at Ronne, near the middle of the west side of the island. In 1800 this place employed 60 vessels and 130 boats, chiefly in the fisheries.

The first shore on the south of the Baltic is that of Holstein, the principal port-town of which is Kiel, a place of considerable commerce. The territory of Lubec succeeds. The city of Lubec is situated on the Trave, five leagues from its mouth. Its commerce is chiefly transit, and on commission, drawing from Russia, Sweden, and Denmark their raw commodities, and supplying them with wines, silks, cloth, hardware, and colonial goods. It admits vessels of from 150 to 200 tons. In 1802 it had from 70 to 80 merchant-vessels, and the same year 1368 entered and 1234 cleared out. Travemunde, at the mouth of the Trave, about nine miles from Lubec, is the port where vessels destined to and from Lubec take their station. The Trave, near Lubec, is joined by the Wakenitz, which, issuing from the Lake of Ratzeburg, thus facilitates the water communication between Lubec and the interior.

On passing the Trave, the duchy of Mecklenburg is entered. Wismar, a bay within the isle of Poel, and Rostock, on the left bank of the Warnaw, three leagues from its mouth, are the principal commercial places in Mecklenburg. The exports from the latter are corn, hemp, flax, hops, wax, butter, honey, cattle, apples, and feathers.

The coast of Pomerania exhibits the effects of the constant action of the waters of the Baltic. On the west, the peninsula of Dars and the island of Zingst form the basin called *Des Dars*, which has six feet depth. The Strait of Gellen, farther east, separates the island of Rugen from the main. This strait varies in breadth from fourteen miles to one and a quarter, and the eastern entrance, called the Bodden, is navigable for the largest vessels; but in the narrows there is only from three to four fathoms; and the sand accumulates so fast here as to require a toll on all vessels passing through it, to defray the expense of clearing it.

The Gulf of Dantzic lies beyond the eastern limits of Pomerania, the western extremity of which, called the Gulf of Putzic, is formed by a curved tongue of land. On the coast of Prussia are the two remarkable basins called the Fresch-Haff and Curish-Haff. The waters of both are fresh, being supplied from the rivers of Poland; and each communicates with the Baltic by a single strait. The Fresch-Haff, which, besides three branches of the Vistula, receives the rivers Elbing, Passarge, and Pregel, is 16 or 17 leagues long and from one to five broad. The communication of this basin with the Baltic has changed several times, and the present passage, near Pillau, was formed by a great storm in 1500; its depth is from 13 to 16 feet. The tongue of land called the Fresch-Nehrung, which separates it from the Baltic, commences near Dantzic, and runs east about 19 leagues; its breadth varies from one to three leagues. The Curish-Haff, or Sea of the Cures, a people of Courland, is 19 leagues long and from one to three broad. Its depth is very irregular, and there are many sand banks in it. Near the upper end there is little current, but in the other parts the currents are very rapid. It communicates with the Baltic by a channel near Memel, 3200 feet wide and from 11 to 13 feet deep. The spit of land which separates it from the Baltic, called the Curish-Nehrung, is about 80 miles long, in some places three miles broad, but in other places

it is so very narrow that the waves of the Baltic wash over it into the basin. Its surface, which is principally sand, continually changes by the fury of the winds. From its ancient name, Mendoniemi, or Promontory of Pines, it was probably covered with those trees. It is inhabited only by fishermen and pilots, whose dwellings are not unfrequently overwhelmed by the sand. It is frequented by immense numbers of crows and hawks; the former of which supply food to the inhabitants, and the tithe of them forms part of the revenue of the pastor.

The whole coast of Prussia and Courland is low, sandy, and covered with pebbles; the latter, however, has calcareous cliffs, which seem to run under water to the island of Gottland. The Gulf of Livonia or Riga has Domesness for its southern limit, between which and the Swaverort is the entrance, eight leagues wide; but from Domesness a sand bank runs off, and a reef from Swaverort. The coast of Livonia, and the islands off it, are in general higher than those of Courland, and are composed of sand, gravel, and calcareous strata. Entering the Gulf of Finland, on the south side is the bay of Roggerswic, inclosed by islands. The whole of the coast of Finland is naked, stony, lined with rocks and islets, and nearly bare of vegetation.

The principal rivers of Prussia that flow into the Baltic are the Oder and the Vistula. The Oder, after dividing into four principal branches near the frontiers of Pomerania, again flows into one stream near Stettin, and falls into the Gros-Haff. Between the Oder and the Vistula several lesser rivers discharge themselves, and being generally navigable, form ports at their mouths. Three of the branches of the Vistula fall into the Fresch-Haff; and the fourth, which alone retains its original name, enters the Gulf of Dantzic at Weixelmunde. The Pregel, which is deeper than the Fresch-Haff, into which it falls, is navigated by vessels of considerable burden. The Elbing issues from Lake Dramsen, and, as has been already noticed, falls into the Fresch-Haff. The Niemen, below Tilsit, separates into two branches, one running to the south-west and the other to the north-west; thus both subdivide, and fall into the Curish-Haff near Memel. The Dange, which gives a port to Memel, has a short course, but is wide and deep.

Stralsund is the first commercial port on the Pomeranian shore of the Baltic. Its harbour is inclosed by jetties, but the access is dangerous and difficult, on account of sand banks. It has a considerable export trade in brandy, starch, and linens. Stettin, on the Oder, succeeds. Vessels of moderate burden go up to it, but large ones discharge at Swinemunde, on the channel into the Gros-Haff, which separates the islands of Usedom and Wollin. Between the years 1787 and 1796 the annual exports were 3714 tons. The imports consist of manufactured goods from England; salt, wines, and fruits from France, &c.; and linseed from Russia. About 160 vessels, manned by 1000 seamen, belong to it. From Politz, near the mouth of the Oder, are exported several thousand bushels of hops, chiefly to Sweden.

The principal islands off the coast of Pomerania are Rugen, Usedom, Ruden, and Wollin. Rugen is separated from the mainland by the Strait of Gellen. It is of a very irregular shape, and consists of the island proper and three peninsulas. It is supposed to contain 142,000 acres. Two of the peninsulas terminate in promontories, composed of chalky cliffs, one of which is 430 feet high. There is no port on the island; but from the roads are exported herrings, cattle, corn, and salted geese. The coasts are very dangerous, scarcely a year passing in which some vessels are not stranded; and several ancient regulations are still in force respecting the assistance which

Baltic. the inhabitants are bound to give in case of shipwrecks. The islands of Usedom, Ruden, and Wollin, are formed by the alluvion of the Peene and the Oder; they are very low, and in general sandy.

Dantzic is the principal commercial place in Prussian Poland. It is situated on the western branch of the Vistula, five miles from its mouth, and at the confluence of the rivulets Motlau and Radaune. These form its port, to which there is an entrance by a canal giving a new channel to the Vistula, the old one being choked up. Dantzic has long justly been considered one of the granaries of Europe. Its annual exports of corn average about 700,000 tons. Its other exports are timber, beer, brandy, horse-hair, hogs' bristles, feathers, wool, amber, honey, wax, linens, masts of ships, cork-wood, hemp and flax, potash, salt, tar, skins, fruits, &c. Its imports are English manufactures and London porter, herrings, fruits, lead, coffee, tea, sugar, indigo, wines, &c.

Pillau, whence there is a considerable export of timber, stands on a peninsula washed by the Fresch-Haff on one side, and by the Baltic on the other. From Königsberg, on an island at the mouth of the Pregel, are exported nearly the same articles as from Dantzic, in between 600 and 700 vessels annually. From Elbing, at the mouth of the river of the same name, corn, starch, linseed oil, soap, cordage, sail cloth, saltpetre, potash, and timber, are exported in between 300 and 400 vessels annually. The port of Memel, formerly the mouth of the river Dange, is liable to be encumbered with mud; its chief exports are ship timber, masts, linseed of a superior quality, hemp, flax, hides, and tallow.

The first Russian river of consequence that falls into the Baltic is the Western Dwina. It is navigable from its source to within a few miles of Riga, where ridges of rocks form fourteen falls. These, however, do not prevent the floating down of immense quantities of timber. It is frozen from the end of November to the beginning of April. It separates Courland from Livonia, and, after a course of 180 leagues, falls into the Gulf of Livonia before Riga. The Narowa, which is the only outlet of Lakes Peipus and Plaskoff, falls into the Gulf of Finland at Narva, but its navigation is obstructed half a league above that town by a fall. The Neva, which issues from Lake Ladoga, disembogues itself by several branches at Petersburg, above which it is from 150 to 200 fathoms broad. It is shallow, and is frozen from the end of October to the end of April. The principal rivers in Finland are the Wuoxen, which falls into Lake Ladoga; the Kymene, which discharges itself into the Gulf of Finland; and the Kumo, Uleo, Kemi, and Torneo, which fall into the Gulf of Bothnia, at the towns of their respective names. In Courland, Russia has only two ports of any commercial consequence, Liebau and Windau. From the former, on a river of the same name, 111 vessels cleared out, and 113 entered it, in the year 1800; and the value of its exports amounted to 1,065,700 rubles, and of its imports to 620,000. Riga and Pernau are the principal ports in Livonia. Riga is one of the most commercial cities of the Baltic, and the second of Russia in this respect. Its port can only receive small vessels, large ones being obliged to lie in the roads. The exports consist of corn, hemp, flax, ship timber, pitch, potash, hides, tallow, iron, &c. The imports are woollen and cotton goods, hardware, wines, oils, spirits, and colonial produce.

Though the entrance to Revel is through dangerous shoals, and the town stands on a river which affords little or no intercourse with the interior, yet its commerce is considerable. Its exports and imports are nearly the same as Riga.

Petersburg is built on both sides of the Neva, and on

several islands. The mouth of the river being choked by sand, there are only from seven to eleven feet of water over it, according as the wind blows from the east or west. With easterly winds the river often falls three or four feet below its general level, whereas westerly winds sometimes raise it from ten to fifteen feet. Loaded ships of any considerable burden cannot, therefore, approach within four miles of the city. The principal exports are iron, hemp, flax, cordage, tallow, hides, linseed oil, hemp and flax seed, planks and rafters, leather, soap, candles, wax and honey, fish, caviar, tobacco, rhubarb, tea, isinglass, feathers, linen, and furs. The principal imports are English cotton manufactures, French wines, colours, coffee, sugar, drugs, &c.

Cronstadt, the principal station of the Russian fleet, is built on a little island on the Gulf of Petersburg, four leagues below the city, the same distance from Ingria, and nine leagues from Finland. The channel to the capital lies between this place and the coast of Ingria. Its navigable breadth is three quarters of a mile, its depth four fathoms. The channel between Cronstadt and the coast of Finland has only five feet of water. Cronstadt has three havens, two for ships of war and one for merchant vessels. The dry docks, which communicate with the sea by a canal, require nine days to empty them. The principal man of war's port has space for thirty sail of the line.

The first commercial port in Finland is Wyborg, built on a peninsula in a gulf of the same name. It exports corn, butter, tallow, fish, fish oil, salted provisions, timber, tar, and hops. Helsingfors, the best port in Finland for large ships, is on a bay; and opposite to it is Sveaborg, the Gibraltar of the north. It occupies seven islands, and has two basins for repairing ships of the line and smaller vessels. At the entrance of the Gulf of Bothnia, on a peninsula, stands Abo. Vessels drawing nine or ten feet go up to the town. While it belonged to Sweden it was a staple town, with some trade to the Mediterranean, France, and Holland, whither it exported iron, nails, copper, deals, rafters, pitch and tar, salted provisions, hides, furs, coarse linens, and firewood, to Stockholm and Copenhagen. From Abo there is no commercial place of consequence till we come to Gamla Carlby, which, in 1794, had fourteen ships of 1530 tons, thirteen of which were employed in foreign trade. Its exports that year were 1800 barrels of tar, 1500 of pitch, between 3000 and 4000 deals, 2000 lbs. of butter, 273 cwt. of tallow, and 900 barrels of corn. Brahested, a staple town while Finland belonged to Sweden, possesses commerce nearly of the same kind and to the same amount as Gamla Carlby. It lies in a bay between two peninsulas. Uleoborg, the chief town of East Bothnia, on the Uleo, exports annually a considerable quantity of pitch and tar, butter, tallow, salmon, pike, herrings, and deals. On the islands at the mouth of the river are two building places, from which five or six ships are launched annually. Torneo is situated on a peninsula, and had formerly a good harbour, but the accumulation of sand has almost ruined it. The exports, besides the general articles from the other ports of Finland, are salted and smoked rein-deer flesh, and the furs of the rein-deer, fox, wolf, and ermine, procured from the Laplanders, who visit the town once a year.

The Russian islands at the northern extremity of the Gulf of Livonia, Oesel and Dagœ, and the numerous islands and rocks in the Gulf of Finland, require no particular notice. The archipelago of Aland, which was ceded to Russia along with Swedish Finland in 1809, is composed of one considerable and above eighty lesser islands and rocks. They are in general elevated, rising on rocky peaks, with numerous caverns. The principal island is nearly round, and twenty leagues in circumference. There is no town

Baltic.

Baltic. on any of them. Besides fire-wood, 12,000 loads of which are sent annually to Finland and Sweden, the inhabitants export salted beef, seal skins and oil, tallow, hides, pilchards, and butter, chiefly to Stockholm.

Canals of the Baltic. IV. The commerce of the Baltic is considerably facilitated and increased by means of different canals, which form a communication with different parts of it, with it and other seas, and with the interior of the countries, the shores of which it washes.

The ancient Scandinavian chronicles mention a natural water communication between the Baltic and the German Ocean through the Danish peninsula, by means of the Gulf of Kiel, the river Lewensau, the lake Flemhud, and the river Eyder. When the communication ceased to be practicable, an attempt to renew it was made in the middle of the seventeenth century by the duke of Holstein Gottorp. It did not however succeed, in consequence of the opposition of the king of Denmark. The union of Holstein and Denmark taking place in 1773, the proposed canal was begun in 1777, and finished in 1784. It enters from the Baltic by the Gulf of Kiel, near the mouth of the Lewensau, the waters of which serve to supply it; then joins the northern extremity of Lake Flemhud, unites with the Upper Eyder; passes by Rendsburg, and falls into the German Ocean at Tonningen. The perpendicular fall towards the Baltic is twenty-five feet six inches, and that towards the ocean twenty-three. To Lake Flemhud, which is the highest point, vessels are drawn by horses, and elevated by three locks of nearly ten feet fall each; three other locks lower them to the Eyder; and from Rendsburg to Tonningen vessels use their sails. The whole length of the navigation from sea to sea is about 105 miles, of which the canal forms $20\frac{1}{2}$: its breadth is 100 feet at top, 54 at bottom, and the least depth 10 feet, so that it can admit vessels of about 140 tons burden. Upwards of 2000 pass it annually. The Baltic and the German Ocean are also united by means of the canal of Stecknitz. This canal unites the rivulet of that name which falls into the Trave with the Devenau, a rivulet that runs into the Elbe at Lauenburg. This navigation is fit only for flat-bottomed boats, and is very tedious.

The Baltic has communication with the interior of Germany by the canals of Muhlrose and Finow. The first unites the Oder above Frankfort with the Spree, one of the tributary streams of the Elbe. The canal of Finow joins the river of this name, which falls into the Oder, with the Havel, another branch of the Elbe. By means of these and some lesser canals a long navigation through Silesia, Brandenburg, Lower Saxony, and Pomerania, is maintained. There is also an artificial navigation which unites the Vistula and the Oder: this is the canal of Bromberg, which joins the Brahe, a tributary of the Vistula, with the Netze, which falls into the Warthe, and the latter into the Oder. The Niemen, in conjunction with the Dnieper, affords a communication between the Baltic and the Black Sea; the canal of Pinsk uniting the former river near its head with the Priapetz, which falls into the Dnieper. These seas are also united by means of the Dwina and Dnieper. The boats employed in this navigation ascend the Dwina to the Ulla, which they also ascend as far as the Lake Bieloe, out of which it flows. By crossing this lake they reach the river Essena, which they ascend to Lake Beresina. Here they enter a canal four leagues in length, which conveys them into Lake Plawia. From this lake flows the river Sargutsch, which joins the river Beresina, and this latter falls into the Dnieper; but the cataracts in this river, about 250 miles above its estuary, greatly impede the intercourse which might otherwise be established by these two navigations between the Baltic and the Black Sea.

The Baltic and Caspian Sea are united by the canals

of Ladoga and Vyschnei Volotschok. The canal of Ladoga, so called, not because it enters that lake, but as winding along its margin, extends from the river Volchof to the Neva. In the original navigation the boats passed from the canal of Ladoga up the Volchof to Lake Ilmen, and from this lake entered the river Masta; but in consequence of the fatal accidents that happened on the rapids of this river, one of which is six or seven leagues long, a canal was cut directly upon the Volchof to the Masta above the rapids. The old route is here only followed at a certain season, and by boats of a peculiar construction. Ascending the Masta, the boats enter the Lake Mstinskoja, and thence the river Shlina, from which, by means of a canal with a lock, they enter the Sna, and by another lock the canal of Vyschnei Volotschok. This is a league in length, and from it a lock lowers the boats into the Twerza, which they descend to the Wolga. In order to facilitate the ascending navigation from Petersburg, which is rendered tedious by the rapidity of the Volchof and the Masta, a canal has been cut, combining the Tichwin, which falls into the Ladoga, and the Somina, which falls into the Molaga, a tributary of the Wolga. In spring the vessels may draw two and a half feet water, but in summer only twenty-six inches. In autumn the navigation from Vyschnei Volotschok to Petersburg is performed in rather more than a month, in summer in three weeks, and in spring in a fortnight.

By these canals a navigation is established nearly the whole way from Petersburg to the frontiers of China, there being an interruption only in two places, both not more than sixty miles. The distance from Petersburg is between 1600 and 1700 leagues; but the rivers being navigable only in the fine season, it requires three years to complete the passage. The extent of the commerce is about one and a half million of rubles annually.

The Baltic and the Caspian are also connected by the canal of Maria. The boats ascend the Neva, cross the Lake Ladoga, and enter the Swir, which they ascend to Lake Onega. From this lake they ascend the Wytegra, which is united by the canal of Maria to the Kowska. By ascending this they arrive at Lake Bieloe, and crossing it enter the river Tchesna, which they descend to the Wolga. A canal has long been projected to form a communication between the Baltic and the White Sea; but though it was begun more than fifty years ago, there is only a small portion of it executed.

Ever since the time of Gustavus Vasa, the Swedes have been anxious to form an inland navigation between Stockholm and the Cattegat, principally in order to avoid the payment of the duties of the Sound, and Danish privateers in case of war. This navigation presented no very formidable difficulties. The Gotha flows out of Lake Venar; this is at no great distance from Lake Hielmar; and this again is still nearer Lake Mælar, which communicates with the Baltic at Stockholm. Hence it appears that the plan of forming an internal water communication between Gottenburg and the capital may be divided into three principal parts; the junction of the Hielmar and the Mælar, of the Hielmar and the Venar, and the rendering the Gotha navigable from the Venar to Gottenburg. The Hielmar is seventy-three feet higher than the Mælar, which is six feet above the Baltic. These two lakes were united in the reigns of Christina, Charles XI., and Charles XII., by the small river Ulvison and the canal of Arboga. Nine locks are necessary to establish this communication. The obstacles that opposed the navigation of the Gotha from Lake Venar were principally just at its first issuing from that lake, at the four cataracts, twenty leagues above Gottenburg, called by the general name of Trollhæta; the fall of Akerström, about a mile below these cataracts, and

Baltimore a bed of rocks at Edit, considerably nearer Gottenburg. The first impediment was removed in the reigns of Charles XI. and XII. by the Carlsgraf Canal. Attempts were made to remove the second by carrying a canal along the channel of the river; but these not succeeding, it was resolved to cut the canal through the solid rock which forms its banks. This work was begun in 1793, and completed in seven years. The canal commences below the first fall of Trollhæta (for this fall, by the former plan, had been nearly turned into still water), and is carried nearly a league before it again joins the river; its breadth is twenty-two feet and its depth six and a half, and it has eight locks and a large reservoir. A communication between Lake Mælar and the Lake Sodra Barken, on the borders of Dalecarlia, is effected by means of the canal of Stræhms-holm, several small lakes, a river, and several locks, some of which have a fall of thirty-eight feet. A communication between Lake Mælar and the Baltic, considerably to the south of the exit of that lake, and much shorter than by it, is afforded by means of a canal that joins Lake Mælar with the Sound, at the head of which stands the town of Sæder Telje.

See Thomson's *Travels in Sweden*; *Tableau de la Mer Baltique*, par Catteau; *Tableau des Etats Danois*, par Catteau; Macpherson's edition of Anderson's *History of Commerce*; Oddy's *European Commerce*; *Maritime Geography and Statistics*, by Tuckey.

BALTIMORE, a decayed town of Ireland, in the county of Cork, situated on a headland projecting into the sea, with a good harbour. It is 13 miles south-east of Bantry.

BALTIMORE, a town of Maryland, in North America. It is situated round the head of a small bay, which is an arm of the Chesapeake, and near the mouth of the river Patapsco. The basin which forms the harbour is of a circular form, with a narrow entrance guarded by a fort, and is large enough to contain 2000 merchant vessels. Baltimore is now the third port, in point of trade, in the United States, New York and Philadelphia only being superior. Its progress has been rapid beyond example. In 1750 it was a village of ten or twelve houses, and in 1818 it contained 60,000 inhabitants. The merchants here are considered among the most enterprising in the United States. The tonnage belonging to the port in 1815 amounted to 107,137 tons. A British force attacked Baltimore in September 1814; but the ships of war being unable to force the entrance to the harbour, the attack by land proved unsuccessful, and the troops withdrew, with the loss of the commander, General Ross, and 200 men. The houses in Baltimore are generally well built, and many of the public edifices are extremely handsome. The Roman Catholics are the most numerous class; the other considerable sects are the Episcopalians, Presbyterians, Baptists, and Quakers. The democratic party have a more decided superiority in Baltimore than in any other great city in the United States. Long. 76. 40. W. Lat. 39. 10. N.

BALTINGLASS, a town of Ireland, county of Wicklow, on the river Slaney. It carries on a manufacture of linen and woollen cloths. Here an action took place in 1798, between the royalists and the insurgents, in which the latter were defeated. The population is 1500, and it is 37 miles south by west of Dublin.

BALUBALAGAN, a cluster of thirteen small, flat, wooded islands in the Straits of Macassar, having navigable channels between them, but uneven anchorage. There is a fishery here for *biche-de-mer*.

BALUSTER, a small kind of pillar used for balustrades.

BALUSTRADE, a series or row of balusters, joined by a rail, and serving as well for a rest to the elbows as for a fence or inclosure to balconies, altars, staircases, &c.

BALUZE, ETIENNE, a writer eminently distinguished by his knowledge of history, ecclesiastical antiquities, and the canon law, was born at Tulle on the 24th of December 1630, being the descendant of a family which had long adhered to the legal profession. He received his elementary education at the place of his nativity, and afterwards prosecuted his studies in the university of Toulouse, where he obtained an exhibition in the College of St Martial. Having finished his course of philosophy, he commenced his attendance in the schools of law; but although he attained to great proficiency in certain departments of jurisprudence, he felt no inclination for the ordinary occupations of a lawyer, and never followed the profession of an advocate. He possessed a natural alacrity of mind, and was capable of the most intense literary exertion; and his life being prolonged beyond the ordinary limits, he successively engaged in many undertakings of great research and of great utility. Before he quitted the university, he appeared in the character of an author. His earliest inquiries related to different subjects of ecclesiastical antiquities; and the reputation which he thus acquired recommended him to the notice of M. de Montchal, archbishop of Toulouse, who granted him access to his library. This prelate was succeeded by M. de Marca, who soon became archbishop of Paris, and who was profoundly skilled in those branches of knowledge which Baluze so long continued to cultivate. In 1656 the archbishop invited him to the metropolis. Here he improved in the good graces of his patron, and even participated in his learned researches. From an individual of so much influence at court, he might naturally have hoped for a competent share of preferment; but before his hopes were realized, the prelate died on the 29th of June 1662.

He speedily found another favourer of his studies in M. le Tellier, afterwards chancellor of France, who, with the view of engaging him in the service of his son the Abbé le Tellier, the future archbishop of Reims, conferred upon him many benefits, of which he retained a grateful remembrance. But, from various causes, the proposed arrangement never took place; and he was next connected with the establishment of M. de Lamoignon-Houdancourt, archbishop of Auch. In 1667 M. Colbert offered him the situation of keeper of his library, one of the most magnificent private collections in Europe; and its value, both in manuscripts and in printed books, was greatly augmented by the judgment and zeal of the learned librarian. Having retained his office for some time after the death of Colbert, he resigned it in the year 1700: the library had then descended to the archbishop of Rouen, and he had ceased to find his situation agreeable. He appears to have occupied apartments connected with the library; and we are informed that he now retired to a house belonging to the Scottish College.

In the year 1668, the Abbé Faget published some works of his relation M. de Marca; and, in the life prefixed, he took occasion to state, that when the prelate was at the point of death, he enjoined Baluze to place all his papers in the hands of his son the president. He had in reality committed his manuscripts to the care of Baluze himself, who was therefore greatly offended at this statement, and vented his spleen in different letters. The abbé replied in the same strain, and afterwards inserted their angry correspondence in his collection of Dissertations. The heat which Baluze displayed upon this occasion excited the more surprise, as his disposition was habitually gentle. Of his animosity against Faget he has left a further record in his life of De Marca, prefixed to the treatise *De Concordia Sacerdotii et Imperii*.

In 1670 he was appointed professor of the canon law in the Royal College. The canon law had long been taught

Baluze.

Baluze. in the university of Paris, and there indeed it was long taught to the entire exclusion of the civil law; but this was a new chair which the king was pleased to erect in his favour; and of his high qualifications for such a professorship he has left the most unequivocal proofs. Nor was this the only preferment which his learning procured him. He was appointed a canon of the cathedral of Reims; and in the privilege appended to his edition of Marius Mercator, printed in the year 1684, he is designated "Estienne Baluze, prieur de Beauvais." It may therefore be inferred that he enjoyed a considerable pension from that abbey; nor were such arrangements uncommon at that period of the history of France. He is described as "simple tonsuré;" an expression which denotes that he was not a priest or a deacon, but had only been initiated into one of the lowest of the seven holy orders. In order to recompense M. Martin, who had been the tutor of Colbert's children, that minister had procured him a pension of 2000 livres, payable out of the bishopric of Auxerre; but the conscientious ecclesiastic represented to his patron that he had rendered no services to the diocese of Auxerre, and therefore could accept of no share of its revenues, more especially as a compensation for services which were not of a spiritual, but of a temporal nature. One half of this pension was then bestowed upon Baluze, whose scruples do not appear to have been equally powerful. In 1683 he had published a volume of councils, and it was his original intention to extend the collection to several volumes; but some of the materials which he had prepared could not be much relished at Rome; and as his pension required the sanction of that most corrupt of all courts, he thought it expedient to abandon his design. Of the acts of the council of Basel he had proposed to print a very ample collection; and this was indeed the part of his plan for which the whole had chiefly been undertaken. After an interval of ten years, he published his lives of the popes of Avignon; a work of curious research, which procured him a pension from the crown, and afterwards the office of director of the Royal College, where he succeeded the Abbé Gallois in the year 1700. But the favour of a court is at all times and in all places held by a very precarious tenure. Baluze, who had attached himself to Cardinal de Bouillon, and had been employed in writing the history of his family, was involved in the disgrace which attended this illustrious prelate. He had traced the cardinal's lineage to the ancient dukes of Guienne and counts of Auvergne; and when his patron had retired to a foreign country, the tyranny of Louis XIV. endeavoured to mortify him in the person of his family-historian, who was charged with abetting the cardinal's pretensions to independence. A *lettre de cachet* removed him from Paris: his place of exile was repeatedly changed, and his residence successively restricted to Rouen, Blois, Tours, and Orleans; nor could he obtain his recall till the year 1713, after the peace of Utrecht: but although he was at length permitted to revisit Paris, he never recovered his two offices of director and professor of the Royal College. Such proceedings as these, which were very far from being uncommon, are sufficiently characteristic of the old despotism of France.

Although this persecution commenced when he had nearly attained the age of eighty, it did not quench his literary ardour; for, during his exile, he employed himself in preparing an edition of the works of St Cyprian, which was published after his death. His constitution had never been vigorous, but the sobriety and regularity of his habits enabled him to reach a mature and healthy old age; and, according to the expression of Nicéron, he lived with pleasure

and died with resignation.¹ He died on the 28th of July 1718, in the eighty-eighth year of his age; and his remains were interred in the church of St Sulpice. A person who had lived so long in the midst of learned dust, without either wife or children to blow it aside, could not well be without his share of peculiarities. He was not entirely exempted from caprice, and his testament exhibited this caprice in no very amiable light; his relations and domestics were almost totally forgotten, and the bulk of his property was bequeathed to a woman who appears to have had no claim upon him. Some scholars, who have collected libraries with much labour and at great expense, are inclined to cherish an anxious wish that they should be preserved entire; but, on the contrary, he was desirous that his library should be sold in detail, lest any one individual should be put in possession of those literary treasures which he himself had gradually amassed. This collection consisted of 10,799 articles, including more than 1500 manuscripts, together with 115 printed books which he had interspersed with annotations. The manuscripts were added to the Royal Library.

Baluze was a man of great learning and research in those departments to which he had devoted his chief attention; and his publications have in an eminent degree elucidated various branches of law, history, and antiquities. His merits are perhaps more conspicuous as an editor than as an author. He was particularly conversant with ancient manuscripts; and being likewise possessed of much erudition and critical skill, he has published valuable editions of many ancient monuments. If his labours had not extended beyond the *Capitularia Regum Francorum*, his name would always have been mentioned with respect by lawyers and historians; but some of his other publications greatly illustrate the history of the middle ages; nor must we forget the light which they reflect upon the history of the canon law, and upon the writings of the Latin fathers.

Of the principal works which he published in a separate form we shall subjoin a catalogue, interspersed with a few brief notices.

1. *Antifrizonius*. Tolosæ, 1652, 12mo.—This work contains an exposition of the inaccuracies to be found in the *Gallia Purpurata* of Pierre Frizon, a doctor of the Sorbonne, published in 1638.

2. *Dissertation sur le Temps où a vécu S. Sadroc, Evêque de Limoges*. Tulles, 1655, 12mo.

3. *Dissertatio de Sanctis Claro, Laudo, Ulfardo, Baumado, quorum sacræ Reliquiæ servantur in Cathedrali Ecclesia Tutelensi apud Lemovices*. Tutelæ, 1656, 8vo.

4. *Petri de Marca, Archiepiscopi Parisiensis, de Concordia Sacerdotii et Imperii, seu de Libertatibus Ecclesiæ Gallicanæ, libri viii. a Stephano Baluzio emendati*. Paris. 1663, fol. Paris. 1669, fol. Paris. 1704, fol.—The first edition, consisting of four books, had been published in 1641, when the author was president of the parliament of Pau. The edition of 1663 contains four additional books; and the two subsequent editions received further augmentations from Baluze. The life of the author had been published in a separate form, under the title of "*Stephani Baluzii Tutelensis, Canonici Remensis, Epistola ad clarissimum et eruditissimum virum Samuelem Sorberium, de Vita, Rebus gestis, Moribus, et Scriptis illustrissimi viri Petri de Marca, Archiepiscopi Parisiensis*." Paris. 1663, 8vo.

5. *Salviani Massiliensis et Vincentii Lirinensis Opera, ad fidem veterum codicum manuscriptorum emendata, notisque illustrata*. Paris. 1663, 8vo. Paris. 1669, 8vo. Paris. 1684, 8vo.—The last edition is considered the best.

¹ Nicéron, *Mémoires pour servir à l'Histoire des Hommes illustres dans la République des Lettres*, tom. i. p. 199.

Baluze.

6. Servati Lupi, Presbyteri et Abbatis Ferrariensis, Opera. Paris. 1664, 8vo.

7. S. Agobardi, Archiepiscopi Lugdunensis, Opera; item Epistolæ et Opuscula Leidradi et Amulonis Arch. Lugd. notis illustrata. Paris. 1666, 2 tom. 8vo.

8. Concilia Galliæ Narbonensis, cum notis. Paris. 1668, 8vo.

9. S. Cæsarii, Arelatensis Episcopi, Homiliæ xiv. notis illustratæ. Paris. 1669, 8vo.

10. Petri de Marca, Archiepiscopi Parisiensis, Dissertationes tres: Stephanus Baluzius in unum collegit, emendavit, notis illustravit, et appendicem adjecit actorum veterum. Paris. 1669, 8vo.

11. Reginonis Abbatis Prumiensis libri duo de Ecclesiasticis Disciplinis et Religione Christiana; accessit Rhabani Archiepiscopi Moguntini Epistola ad Heribaldum Episcopum Antissiodorensis, cum notis. Paris. 1672, 8vo.

12. Antonii Augustini, Archiepiscopi Tarraconensis, Dialogorum libri duo, de Emendatione Gratiani, cum notis. Paris. 1672, 8vo.—Gratian, as the learned reader is sufficiently aware, was the compiler of the *Decretum*, one of the constituent parts of the *Corpus Juris Canonici*. His work is not without errors and inconsistencies, which are discussed with a considerable degree of freedom by the very distinguished archbishop of Tarragona; and his text is ably illustrated in the annotations of Baluze. The text and the notes were soon afterwards republished by another eminent canonist. "Ant. Augustini, &c. libri duo. Gerh. von Mastricht, J. C. edidit iterum, recensuit, in hanc formam digessit, et Stephani Baluzii suasque notas in eundem et Gratianum, item in fine Orationem Andr. Schotti, de Vita et Scriptis Auctoris, adjecit." Duisburgi ad Rhenum, 1677, 8vo.

13. Petri Gallandi Vita Petri Castellani, Magni Franciæ Eleemosinarii, edente cum notis Stephano Baluzio, qui etiam duas ejusdem Castellani Orationes, habitas in Funere Regis Francisci I., adjecit. Paris. 1674, 8vo.

14. Capitularia Regum Francorum; additæ sunt Marculfi monachi et aliorum Formulæ veteres: Stephanus Baluzius in unum collegit, notis illustravit. Paris. 1677, 2 tom. fol.—In a copy of the book he had inserted many emendations and additions; and after an interval of a century appeared "Nova editio auctior et emendatior ad fidem autographi Baluzii, curante Petro de Chiniac." Paris. 1780, 2 tom. fol. This edition is splendidly printed. Of Baluze's preface a translation was published by L'Escalopier de Nouras, under the title of *Histoire des Capitulaires des Rois Français*. Haye, 1775, 12mo. Another version was published by M. de Chiniac. Paris, 1779, 8vo. It is accompanied with a translation of the life of Baluze, written by himself, and finished by Martin, a bookseller; and likewise with a catalogue of his works, and of the various books in which he had inserted manuscript notes.

15. Miscellanea: hoc est, Collectio veterum Monumentorum, quæ hactenus latuerunt in variis Codicibus ac Bibliothecis. Paris. 1678–1715, 7 tom. 8vo.—A new edition, considerably enlarged, was published by Mansi. Lucæ, 1767, 4 tom. fol.

16. Lucii Cæcilii Firmiani Lactantii liber ad Donatum Confessorem de Mortibus Persecutorum: nunc primum prodit opera et studio Stephani Baluzii. Paris. 1680, 8vo.—The work which he thus rescued from oblivion was pub-

lished from a manuscript in the Colbert Library, and it naturally attracted a great degree of attention. This edition was speedily followed by several others; and an English translation was published by Dr Burnet, afterwards bishop of Salisbury.¹ The preface, notes, and other illustrations of Baluze, are to be found in the edition *cum notis variorum*, published by Paul Bauldri, a French protestant, who was professor of ecclesiastical history in the university of Utrecht. Trajecti ad Rhenum, 1692, 8vo. Various copies of the same edition bear the date of 1693. With respect to the genuineness of this treatise, different opinions have been entertained by learned men; but the claims of Lactantius are satisfactorily stated by Lord Hailes in the preface to his translation: *Of the Manner in which the Persecutors died; a Treatise by L. C. F. Lactantius*. Edinb. 1782, 8vo.

17. Petri de Marca, Archiepiscopi Parisiensis, Opuscula, nunc primum in lucem edita. Paris. 1681, 8vo.

18. Epistolarum Innocentii III., Pontificis Romani, libri xi. accedunt Gesta ejusdem Innocentii, &c. Paris. 1682, 2 tom. fol.

19. Nova Collectio Conciliorum, cum notis. Tom. I. Paris. 1683, fol.—This was intended as a supplement to the great collection of Labbe; and we have already mentioned the reason which induced the editor to discontinue his labours.

20. Marii Mercatoris Opera: Stephanus Baluzius ad fidem veterum codicum MSS. emendavit, et notis illustravit. Paris. 1684, 8vo.—Marius Mercator lived in the age of St Augustin, and somewhat later; but although his works are of some extent, his name is not mentioned by any ancient writer. "Ante hanc ætatem nostram," says Baluze, "nullus inventus est qui mentionem faceret operum Marii Mercatoris, tamenetsi constet his usos esse quosdam veteres scriptores. Primus eorum notitiam habuit vir doctissimus Lucas Holstenius, Bibliothecæ Vaticanæ præfectus." They were first published by Garnier at Paris in the year 1673.

21. Marca Hispanica, sive Limes Hispanicus; hoc est, Geographica et Historica Descriptio Catalauniæ, Barcinonis, et circumjacentium Populorum, auctore Ill. V. Petro de Marca. Paris. 1688, fol.

22. Vitæ Paparum Avenionensium. Paris. 1693, 2 tom. 4to.

23. Lettre pour servir de Réponse à divers Ecrits, qu'on a semé dans Paris et à la Cour, contre quelques anciens Titres qui prouvent que Messieurs de Bouillon descendent en ligne directe et masculine des anciens Ducs de Guyenne et Comtes d'Auvergne. Paris, 1698, fol.

24. Histoire Généalogique de la Maison d'Auvergne, justifiée par des Chartres, Titres, Histoires anciennes, et autres Preuves authentiques. Paris, 1708, 2 tom. fol.

25. Historiæ Tutelensis libri tres. Paris. 1717, 4to.

26. Bibliotheca Baluziana. Paris. 1719, 8vo. This is described as a publication of "plusieurs pièces manuscrites de ce savant auteur." (*Biographie Universelle*, tom. iii. p. 298.)

27. S. Cæcilii Cypriani, Episcopi Carthaginiensis et Martyris, Opera, ad MSS. codices recognita et illustrata studio et labore Stephani Baluzii. Absolvit post Baluzium, ac præfationem et vitam S. Cypriani adornavit unus ex Monachis Congr. S. Mauri. Paris. 1726, fol.—The monk of St Maur, who completed this last labour of the learned and indefatigable editor, was Prudent Maran. (x.)

¹ Amsterdam, 1687, 12mo.—In the preface to his translation, Bishop Burnet remarks, that for this work of Lactantius "the world is beholding to the happy industry of the most learned Baluzius, who having found this treatise, not only communicated it to the world, but enriched it with his learned notes; by which he has added a new essay, to the many that have already appeared, of his great sincerity, his profound learning, and of his solid judgment."

BALZAC, JOHN LEWIS GUEZ DE, born at Angoulême in 1594. He was one of the most distinguished and popular writers of his day, but his works have long since sunk into comparative obscurity. Voltaire allows him the merit of having been the first who gave numbers and harmony to French prose, but censures his style as somewhat bombastic. His writings extend to two folio volumes, which were published in that form in 1665, with a preface by the Abbé Cassaigne; but his reputation was chiefly founded upon his *Letters*, which passed through many editions, and were translated into various languages. He died in 1655, and was buried in the hospital of Notre Dame des Anges, to which he bequeathed 12,000 livres. He also left an estate of 100 franks per annum for a gold medal to be bestowed every two years for the best discourse on some moral subject.

BAMBA, a province of the kingdom of Congo, in Africa. It is situated between the rivers Ambriz and Lose, the last of which separates it from Pemba on the east, as the Ambriz does from the province of Sogno on the north. Along the sea-coast Bamba extends itself northward to the river Lelunda, and on the south to that of Danda. Ambriz is the chief sea-port, and the character of the coast corresponds with that generally described under the head of Angola; but the interior is known only from the imperfect and doubtful accounts of the Portuguese missionaries, who penetrated into it more than two centuries ago.

BAMBARRA, an extensive and important country of interior Africa, with which the journeys of Park, who was perhaps the first European that reached it, have made us tolerably acquainted. It is situated between the 1st and 5th degrees of east longitude, and the 12th and 15th of north latitude. It has on the west the countries of Manding, Kaarta, and Ludamar; on the north Beeroo; on the east Masina and Jinbala, which separate it from Timbuctoo; on the south Baedoo, Maniana, and the high region of Kong. It consists of a spacious and fertile plain watered by the Niger, having on the south the chain of mountains which here traverses the interior of the continent, and on the north the African desert.

In consequence of this situation the climate over the greater part of Bambarra is intensely hot. On the borders of the northern desert it is absolutely scorching. In the sandy tracts, during the middle of the day, the ground is often too hot for the foot to tread upon; and Mr Park, as he lay in his tent, felt sensible pain in applying his hand to the current of air as it entered through the crevices. In the southern districts, which are copiously watered, the air, especially in the mornings and evenings, is much more temperate. In the beginning of June a strong south-west wind begins to blow, accompanied with violent storms and tornadoes, which produce the most pernicious effects on the health, especially of Europeans. This forms the commencement of the rainy season, which continues with violence for three months, during which the country is deluged; all the streams, formerly shallow and almost dried up, now swell and overflow their banks; and the country situated along the Niger and its tributaries is generally inundated. In August the rain ceases, the waters disappear, and the soil is found to be highly improved and fertilized by this alluvion.

The rich plain, thus copiously watered, is fitted for producing in abundance all the richest tropical products. Cultivation also is by no means deficient, though not brought to the same perfection as in the improved districts of Europe; yet the vicinity of the great towns reminded Mr Park of the finest tracts of England. The imperfect diffusion of culture is proved by the circumstance, that there is no private property in land, nor is any price attached to it. It is judged to belong either to the king or

the village; and any individual who wishes an additional quantity may obtain it on application, subject only to a penalty if he fails to bring it under cultivation. The grains chiefly reared are Indian corn, rice, and millet. The plough is unknown; the hoe being, as in other parts of native Africa, the only instrument used in turning up the ground. The pine-apple, orange, banana, and other fine fruits peculiar to tropical countries, though partially introduced on the coast, have not found their way into this interior kingdom. Several peculiar and valuable trees and shrubs, however, are produced on its plains. Among these is the shea-toulou, or tree producing vegetable butter. It very much resembles the American oak; and the valuable substance consists in the kernel of a nut, somewhat resembling a Spanish olive. The butter, in Mr Park's opinion, is firmer, whiter, and of richer flavour than that made from cow's milk, and has the advantage of being easily preserved during the whole year without salt. In the neighbourhood of Sego it grows in peculiar abundance, and forms a subject of export to the surrounding countries. The lotus, a celebrated and classical shrub, whose berries, on being pounded and dried, are formed into cakes resembling the best gingerbread, grows along the northern border of Bambarra; to which may be added the kolla or gooroo nut, the agreeable bitter taste of which is universally relished by the negroes. Cotton and indigo, as the materials, the one for weaving, the other for dyeing their cloths, are cultivated with diligence and success. Tobacco is cultivated; but neither the sugarcane, the coffee, nor the cocoa-tree, appears to be even known in this part of Africa.

The staple manufacture in Bambarra, and, indeed, generally in central Africa, is that of cotton stuffs dyed with their fine indigo. The process is exceedingly simple; the juice of the indigo leaves is extracted by pounding, mixed in a lye of wood ashes, and the cloth is then steeped in the vat. By this process a beautiful and durable colour is produced. The natives have also the art of tanning the leather of sheep and goats, and staining it with red and yellow colours. They possess, besides, the art of smelting iron, and forming it into spears, hoes, and other warlike and useful instruments; but they have in vain attempted the fabrication of fire-arms. They fashion the gold which abounds in the neighbouring districts into bracelets, necklaces, and other ornaments, with a variety of taste and an elegance of fancy which would excite admiration in the best European workmen.

The commerce of Bambarra is carried on partly along the Niger, partly by inland caravans proceeding in different directions. The Niger becomes navigable at Bammakoo, the very point where it enters Bambarra, and continues to be so during its whole course through that kingdom. The trade is considerable, and numerous boats are seen passing and repassing. These boats are of a singular construction, consisting of the trunks of two large trees hollowed out, and joined together lengthwise, without decks or masts. They are disproportionably long and narrow, though very capacious, since Mr Park saw in one of them four horses and a great many passengers crossing a ferry. The most extensive traffic, however, here, as in all the countries of interior Africa, is carried on by land-caravans. The chief object of import is salt, a necessary of life of which Bambarra, like all the tracts situated on the interior rivers, is entirely destitute; but it is procured from large pits in the interior of the desert. There are imported, also, considerable quantities of European goods, arms, cloths, toys, and ornaments. These are brought partly from the coast, partly from Barbary by way of Timbuctoo, partly by the direct route from Aroan to Sansanding. The exports consist of gold, not

Bambarra. produced within the kingdom itself, but in the high districts to the south, and found in the sands of the rivulets which fall into the Niger, whence, by mere agitation in water, it is separated in the form of dust. The other great staple consists in slaves, for which, till lately, the European settlements on the coast afforded so very extensive a market. The slaves from Bambarra, belonging to a more civilized and industrious race than the inhabitants of the turbulent little states into which Africa is generally divided, are subjected to less restraint, and bear a higher value in the market. This unjust and calamitous traffic, which excited and prolonged African wars, has been greatly diminished since the prohibition by England of her own trade, and since she obtained permission from the other powers to put a stop generally to that carried on north of the line. Doubtless, however, there is still an extensive contraband.

Bambarra is the point where the two great races of interior Africa, the Moors and negroes, meet and mix with each other. The great inroad by which the former have occupied so large a proportion of this continent, is bounded generally, though not uniformly or completely, by the Niger. The nations to the north and east of Bambarra are mostly Moors, to the south and west negroes. Within the country itself the negro is still the ruling power; though in many of the large eastern towns the Moors are the most numerous, and have the almost entire municipal jurisdiction. They are generally superior to the natives in intelligence, and, as in the rest of Africa, are a stirring, trafficking, bigoted, turbulent race. Their fanatical enmity to Christians probably causes them present themselves to our travellers under a more unamiable aspect than they would otherwise exhibit. They are possessed of some knowledge of letters, of which the native tribes are altogether destitute; and by imparting these first elements of knowledge, they extend both their faith and their influence. They make a much less laudable use of the credit thus acquired, by composing saphies or charms, to which the credulous negroes attach the most extraordinary virtues, purchasing at a high price this delusive mode of protection. The negroes, on the other hand, are a race generally harmless, thoughtless, voluptuous, but kind and open-hearted. Their hospitality was in several instances signally displayed towards Mr Park, and "to suffer the king's stranger to depart hungry, was considered an heinous offence." They possess a good deal of agricultural industry, practise some fine manufactures, and have even a talent for extemporary poetry; but their intellectual culture on the whole ranks very low. Polygamy is generally established, though only the chiefs and very opulent individuals can or do carry it to a great extent. Domestic slavery is also general, but under a mild form; the master and slave living almost as equals, and sometimes eating at the same table.

Sego, or Sego-see-korro, the capital of Bambarra, is a large town, containing about 30,000 inhabitants. It is divided by the Niger into two nearly equal parts; and the opposite parts are each divided into two quarters, which being respectively surrounded by a mud-wall, have the appearance almost of separate towns. Although the houses be only of clay with flat roofs, yet those of the higher ranks have two stories, with their roofs whitewashed, while Moorish mosques, with their minarets, rise in different quarters. The city, on the whole, with its highly-cultivated vicinity, presented a scene such as Mr Park little expected to find in the heart of Africa. The communication between the two towns was by a ferry. The chief seat of Bambarran trade is Sansanding, which presented also a scene of busy and orderly traffic, very different from what was expected in the interior of Africa.

The different commodities were well arranged, not indeed in shops or warehouses, but in a spacious public market, shaded by mats from the heat of the sun. In one were the cloths of Houssa, of superior quality to those manufactured in this country: in others indigo, the universal dye; antimony, the great African cosmetic; and beads, the favourite ornament. A separate market, however, was appropriated for salt, the main staple of African trade. The great commercial town of Jenné, farther down the river, was at the time of Park's visit under the jurisdiction of Bambarra; but according to Caillé the connection has since been dissolved.

BAMBOCCIO, a celebrated painter, was born at Laeren, near Narden, in 1613. His name was Peter van Laer; but in Italy they gave him the name of Bamboccio, on account of the uncommon shape of his body, the lower part being one third longer than the upper, and his neck so short that it was buried between his shoulders. Nature, however, had made him amends for the unseemliness of his limbs, in the superior beauties of his mind. His style of painting was sweet and true, and his touch delicate, with great transparency of colouring. His figures were always of a small size, well proportioned, and correctly designed; and although his subjects were taken from the lower kinds of nature, such as plunderings, playing at bowls, inns, farriers' shops, cattle, or conversations, yet whatever he painted was so correctly designed, so happily executed, and so highly finished, that his manner was adopted by many of the Italian painters of his time. We may add that his works are still admired, and that he is justly ranked amongst the class of eminent masters. In the latter part of his life he was severely tormented with an asthmatic complaint, which he endured with much impatience; and it is reported, that as the disorder seemed to him insupportable, he threw himself into a canal to shorten his misery, and was drowned. His death happened in 1673.

BAMBOO. This plant is generally ranked by botanists in the number of reeds; but some, less sensible of its analogies with them, incline to institute a separate genus for it. In the *Systema Naturæ*, Linnæus describes two species, under the genus *Bambusa*, which is characterized thus: "scales three, covering the spikelets, which are about five flowered; calyx none; corolla, a two-valved glume; style bifid; seed one." Loureiro, who had an opportunity of studying the nature of the bamboo in its own climate, characterizes it as having "flowers with six stamina; panicle diffused, with imbricate spikelets; branches of the culm spiny; calyx one flowered." We shall abstain from discussing the more minute botanical characters, as it is to the real utility of the plant that our attention is to be directed. The bamboo is, then, a native of the warmer climates only, though growing luxuriantly without the limits of the torrid zone. It rises to the height of forty, sixty, or even eighty feet, with a slender hollow stem, shining as if varnished. Many, however (probably according to the particular species), are only twelve or fifteen feet high; and those which attain the greatest height here mentioned are rather to be viewed in the same light as the overgrown vegetable productions of our own country. The stem is extremely slender, not exceeding the thickness of five inches in some which are fifty feet high, and in others reaching fifteen or eighteen inches in diameter. The whole is divided into joints or articulations, separated by a short interval, called a knot or internode; and in some there is the distance of several feet between each. Small alternate branches spring from the base to the top, and, together with the narrow-pointed leaves issuing from the knots, give the tree an elegant feathered appearance as it waves in the wind.

The rapidity of growth is surprising in the bamboo. It

Bamboccio
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Bamboo.

Bamboo. sometimes vegetates three or four inches in a single day. Accurate observers have seen it rise twenty feet, and expand as thick as a man's wrist, in five or six weeks; and it has been known to reach thirty feet in six months. This enables us to credit the assertions of those naturalists who maintain that its full dimensions are attained in a year; and that the only subsequent change is greater thickness and induration of the wood. It is always more solid and compact towards the root, and the hollow cells of the stem become wider in proportion as they ascend. In Malabar it is said to bear fruit when fifteen years old, and then to die. Slenderness is a distinguishing characteristic of the whole plant, and it seems probable that there are several different species which have not yet been recognised by systematic botanists. Soil and climate may have also produced effects which would disappear on uniformity of circumstances. An observer of the bamboos of China, in general, considers that there are ten species or varieties, and an observer of those in Cochin-China admits of eight. The former judges the difference to consist, *first*, in the size and height; for there is here the greatest disparity in those that are full grown. *2dly*, The distance of the knots, or length of joint, which, in certain species of full-grown bamboo, is only four inches, while in others young and slender it extends to nine or ten feet. *3dly*, In the colour of the wood, which is whitish, yellow, brown, pale blue, or speckled. *4thly*, In the size and form of the knots, some swelling out from the stem above and below; others encircling it like a cord, and not penetrating within so as to interrupt the tubular part of the bamboo. *5thly*, In the surface and figure of the internodes being channelled or covered with tubercles; and a kind is said to exist called the square bamboo. The varnished surface is also of different quality. *6thly*, In the substance and thickness of the wood, which, varying without any relation to the dimensions of the plant, afford sufficient characteristics for constituting a species. The wood is either soft and tender, or very hard and of great strength; and the stem is either very thin and hollow, or almost totally filled up and solid, like other trees. But elsewhere, in Bangalore for example, this solidity is not ascribed to the difference of species, but to the tardiness of its growth in stony places. *7thly*, It is said that there are bamboos entirely devoid of branches, however old they may be; whilst other branches protrude as they spring from the earth. *8thly*, There is a great difference both in the hue and figure of the leaves, as also in their size; they are bluish, ash-coloured, reddish, or mottled. Some are so large as to make very good fans. *9thly*, The roots, though knotty and irregular, are found in one species to penetrate like a large tuft of filaments into the earth. *10thly*, There are certain singularities which distinguish the species of this plant, as excrescences from the knots, which may be eaten; a saccharine pith; and wood of a red colour and agreeable odour.

It will easily be observed that these remarks are too general to warrant the establishment of species from all the bamboos enumerated; but it is not improbable that a plant so widely diffused may consist, as before observed, of a greater number than has yet been recognised.

The bamboo grows wild in most places of the East, and the warmer parts of the West, and is resorted to as occasion requires. Where the country is principally dependent on its use, it is cultivated in regular plantations, and, in more ungenial climates, preserved by the curious in greenhouses. Its culture is different, according to soil and climate; but apparently it succeeds best in low sheltered grounds, with rich, soft, spongy earth. Contact of the root with water is reputed to be immediately destructive, and too much humidity occasions gradual decay.

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This plant is propagated by shoots deposited in pits at the close of autumn or commencement of winter, eighteen inches or two feet deep; and if it be designed to obtain bamboos of considerable size, the scions are cut over as they spring up. Some scrupulous cultivators among the orientals take care to preserve the plant exactly in the same position, with respect to the cardinal points, as that in which it originated. The greater the number in a plantation, the better is the chance of success, as they shelter each other in their progress. Their subsequent treatment depends entirely on the uses to which they are to be converted, whether of profit or pleasure; much care being bestowed on those designed for beauty or ornament only. They are propped up with rods of a proper height, by which they are trained and supported; and, if complete plants, cut over in order to obtain suitable shoots, which are chiefly sought after; besides, this operation makes the root strike out and take a secure hold of the ground. In a rainy season, it is always necessary to surround the plantation with a ditch, in order to drain off the superabundant humidity, which would otherwise be prejudicial. Various expedients are followed to obtain good bamboos, of which one of the most usual is to take a vigorous root, with firm wood, and transplant it, leaving only four or five inches above the joint next the ground. The cavity is then filled with a mixture of horse-litter and sulphur. According to the vigour of the root, the shoots will be more numerous; but they are destroyed at an early stage during three successive years; and those springing in the fourth resemble the parent tree. It is affirmed that no culture can obtain any thing of larger size.

Scarcely has this plant been put in the ground before its utility becomes conspicuous. The soft and succulent shoots, when just beginning to spring, and only a few inches long, are cut over and served up at table, like asparagus. Like this vegetable, also, they are earthed over to keep them longer fit for consumption; and they afford a supply in succession during the whole year, though more abundantly in autumn. They are also salted and eaten with rice, or prepared after different other fashions. As the plant grows older, a kind of fluid of grateful taste and odour is secreted in the hollow joints, affording an agreeable beverage, and in sufficient quantity to satisfy several persons. If allowed to remain in the tree, a concrete substance, highly valued for its medicinal properties, called *tabaxir* or *tabascheer*, is produced from it. The presence of the fluid is ascertained by agitating the bamboo; after some time its quantity gradually diminishes, and then the stem is opened to reach the tabascheer. This substance, participating in nothing of a vegetable nature, has been supposed to be nearly allied to siliceous earths; it resists the impression of all acids, is indestructible by fire, and with alkalies forms a transparent glass. Notwithstanding its repute in the East, we are not aware that it has yet been received into the European materia medica. Besides the tabascheer, many parts of the bamboo are said to be endowed with medicinal properties; a decoction of the leaves is recommended for coughs and sore throat; the bark for fever and vomiting; the buds as a diuretic; and a compound of the root with tobacco-leaves, betel nut, and oil, is believed to form an efficacious unguent. But setting aside its medicinal properties, it is highly valuable as an article of food, for many of the poorer classes in the most populous countries subsist on it in times of scarcity. The seed which it produces is recorded in Chinese history to have preserved the lives of thousands; the Hindoos eat it mixed with honey as a delicacy, equal quantities of each being put into a hollow joint, coated externally with clay, and thus roasted over a fire.

From the copious draught which a joint of the bamboo

2 U

Bamboo.

Bamboo. naturally yields, mankind are taught its use as a vessel for carrying water, and in some places no other bucket is employed. The eastern nations build their houses solely of the wood, without any auxiliary substance: if entire, it forms posts or columns; split up, it serves for floors or rafters; or interwoven in lattice-work, it is employed for the sides of rooms, admitting light and air. The roof is sometimes of bamboo solely, for which two species growing in Laos, an Asiatic country, are described as specially adapted; and when split, which is accomplished with the greatest ease, it can be formed into laths or planks. It is employed in shipping of all kinds; and as houses are constructed entirely of it, so are complete vessels framed out of it, and fitted for sea. The hull is obtained from the stem; and some of the strongest plants are selected for masts of boats of moderate size. In Bengal a boat of four or five tons may be furnished with both mast and yard from the same bamboo, at the cost of three-pence; and the masts of larger vessels are sometimes formed by the union of several bamboos built up and joined together. Those of considerable dimensions are used in the higher yards of ships of four or five hundred tons, for which service they are well adapted by their great strength and lightness.

The bamboo is employed in the construction of all agricultural and domestic implements; and in all materials and implements required in fishery, hooks and nets excepted. In Thibet the strongest bows are made of it, by the union of two pieces with many bands; and, in the same country also, it is employed, as we use leaden pipes, in transmitting water a distance of several miles to reservoirs or gardens. The species from which these pipes are constructed is said to grow in the mountains; and from other light and slender stalks the inhabitants obtain shafts for their arrows. In the south-west of Asia there is a certain species of equally slender growth, from which writing pens or reeds are made.

From the extreme flexibility of this substance, and also its divisibility, for it splits like whalebone from top to bottom, it can be reduced to the smallest dimensions, and bent into every shape. It is woven into baskets, cages, hats, or various ornamental articles. By a particular process in bruising and steeping the wood or bark, a paste is procured that is made into paper. In short, from its very origin until its decay, it never ceases to produce something beneficial. It has justly been observed: "All that composes a bamboo is profitable, of whatever species it may be. The artists of China have each made their choice, and, in the works they produce, show the advantages they have derived from it. Its uses are so numerous, so various, and so beneficial, that it is impossible to conceive how China could now dispense with this precious reed. It is no exaggeration to affirm, that the mines of this vast empire are of less importance to it than the possession of the bamboo;" which, we may add, is also the chief instrument of government.

It has been proposed to naturalize the bamboo in France. Perhaps were the naturalization of plants and animals attempted by slow and regular gradation, instead of great and sudden transition, experiments might be more successful than former practice has shown them to be. Probably it would require the renewal of several successive generations, each advanced into a different climate, not remote from the abode of the one which preceded it, before naturalization could be completely effected. Some European climates might not prove noxious to the bamboo; but the same rapidity of vegetation, the same natural qualities, could not be expected, or only in an inferior degree, even in the most favourable situation, and consequently its utility would be greatly diminished. (N. N.)

BAMBOROUGH, a village in Northumberland, on the sea-coast, fourteen miles north of Alnwick, was once a royal borough, sending two members to parliament, and even gave name to a large tract extending southward, which was called *Bamboroughshire*. It had also three religious foundations, a house of friars preachers founded by Henry III., a cell of canons regular of St Austin, and an hospital. Its very ancient castle stands on an almost perpendicular rock close to the sea, and accessible only on the south-east side, on a spot where, according to the monkish historians, there stood the castle or palace of the kings of Northumberland, said to have been built by King Ina, who began his reign about the year 559. Part of the present ruin is by some supposed to be the remains of King Ina's work.

BAMBOUK, a country in the interior of western Africa, situated between the Ba-Fing and the Faleme, the two great upper tributaries of the Senegal. The chief characteristic of this country is the quantity of gold with which its soil is almost universally impregnated. This precious metal exists in a perfectly pure state, mechanically united with earth or stony substances in the form of dust, grains, and sometimes little fragments. Almost every spot throughout the country which is within the reach of river inundation is covered with a portion of the ghingam or yellowish earth, which contains gold dust. A portion of this earth is poured into a wooden vessel called a calabash, which is then filled with water, and agitated till the coarse earthy matters are cleared off, and there remains at the bottom a black dust, which by careful washing leaves the gold dust in a pure state. Besides this golden sand or earth, however, Bambouk contains several conical hills entirely filled with that metal, mingled with earth and stony substances, and occurring sometimes in pieces of considerable size. The mine of Semayla is the richest; but the metal is there imbedded in hard substances, and can only be extracted by reducing them to powder, for effecting which the natives have only a pestle of hard wood, which is soon worn away by the attrition of these substances. The mine of Natakou, though less absolutely rich, has the gold only imbedded in softer matters, from which it can be easily extracted. In working the mine one person digs out the sand or stony fragments which contain the gold, and hands them to another, who extracts the metal by the process of pounding or agitation. The natives, finding often a rich vein suddenly terminate, and coming to earth that is wholly unproductive, fancy gold a capricious being, who delights in mocking their research. They often dig out deep pits with perpendicular sides, which fall in and bury the unfortunate workmen employed. The survivors, however, very coolly conclude that a certain potent subterranean deity, whom Europeans name the devil, has carried them off to assist in his own mining operations; but that he treats them well; and when in digging deeper they find the bodies, they merely conclude that this mysterious personage has found them unfit for his purpose, and disdainfully thrown them back. We have seen no estimate, nor do there appear any data from which to form one, of the quantity of gold drawn from the mines of Bambouk; but it is certainly considerable, and is exported partly by way of the coast, partly through Bambarra to Timbuctoo.

The Portuguese, it appears, penetrated early into Bambouk, and were even for some time masters of the country; but the inhabitants, inflamed by their oppressions, made a general rising, and completely drove them out. Since that time the people of Bambouk, with the most extreme jealousy, have excluded all foreigners from their territories. The French, when they formed their settlement on the Senegal, soon directed their eager search

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Banat
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Bancook.

towards a country abounding in so valuable a commodity; but their efforts to penetrate into it proved for a long time abortive. At length, in 1716, one Compagnon succeeded, by great address, and not without risk, in gaining the favour of some leading persons, and obtaining a view of the mineral treasures of this country. David and Levens, two successive French governors, afterwards contrived to effect an entrance. Sieur Brue, the most enterprising of the governors of Senegal, laid before the French administration a plan, by which, with 1200 men, he undertook to conquer and maintain Bambouk. Such an expedition might very probably have been in the first instance successful, and the French might probably, by skilful working, have greatly increased the produce of the mines; but when we consider the various casualties and difficulties attendant on the occupation of this interior region, it must appear very doubtful if this would have been in the end a profitable possession.

Bambouk is fertile and populous along the banks of the rivers, but many of the interior districts are arid and barren. There is a king, but the farims or chiefs compose nearly an independent feudal body. The population is Manding, yet the Mahomedan religion is professed; but the observance consists chiefly in some outward ceremonies, and the marabouts or priests of that faith are carefully excluded from the kingdom. (E.)

BAMBURG, a city of the circle of Upper Maine, in the kingdom of Bavaria, which gives its name to a magistracy. It was formerly under a sovereign bishop, but secularized by the revolution in France. It stands on the Regnitz, in a beautiful situation, surrounded with vineyards and gardens. Like all the ecclesiastical cities, it abounds in religious edifices of some antiquity. The present number of churches is twenty-five, besides the cathedral and fifteen chapels. It has become a place of consideration from its trade, which is assisted by the improved navigation of the Regnitz, and by the manufactures, which have recently been much extended. These consist of linen and woollen cloths, of numerous breweries and distilleries, of leather of all kinds, and of various smaller wares. The inhabitants of the city in 1827 amounted to 20,500, chiefly Catholics. The magistracy extends over sixty-seven square miles, and contains, besides those in the city, a population of 8780 individuals. The city is in long. 11. 48. 16. E. lat. 49. 53. 31. N.

BAMIYAN, a city of Asia, in the province of Zables-tan, ten days' journey from Balk, and eight from Gazna.

BAMPTON, or BAMPTON-IN-THE-BUSH, a market-town of the hundred of Bampton and county of Oxford. It stands in a flat situation near the banks of the Isis, seventy miles from London, and eighteen from Oxford. The church is a magnificent ancient edifice. The market is held on Saturday. The inhabitants amounted in 1801 to 1003, in 1811 to 1232, and in 1821 to 1460.

BAMPTON, a market-town in the hundred of Bampton, in the county of Devon, 164 miles from London, and twenty-one from Exeter. It formerly returned members to parliament, and has now a corporation governed by a port-reeve. The market is held on Saturday. A great battle was fought here in 614, between the West Saxons and Britons, in which the former were defeated with the loss of 20,000 men. The number of inhabitants in 1801 was 1364; in 1811, 1452; and in 1821, 1633.

BANAGHER, a market and post-town of Ireland, in King's county, on the river Shannon, over which is a bridge. The population is 2813; and it is 81 miles west by south of Dublin.

BANALBUFAR, a town on the western coast of the island of Majorca, belonging to Spain, where the best wine is produced. It contains 3745 inhabitants.

BANAT, one of the divisions of Hungary, which is included in the military frontier provinces. It extends over 2973 square miles, or 1,802,720 acres, and contains one market-town, two cities, and 162 villages, with 174,650 inhabitants. The latter are mostly of the Greek church, but about one third are Catholics, with a few Lutherans. It borders on Wallachia, and on the Turkish territory. Part of the Banat consists of a level plain, but much is mountainous, especially towards Wallachia, where it comprehends a portion of the Carpathians within its boundary. It is very productive in corn, cattle, flax, and hemp; but the cultivators want markets and access to places of consumption. There are none but domestic manufactures. The chief city is Pancsova, at the junction of the Themes with the Danube.

BANBURY, a market and borough-town of the hundred of Banbury, in the county of Oxford, seventy-five miles from London. The corporation consists of a mayor, recorder, high steward, and six burgesses, who returned a member to the House of Commons, in the election of whom the Earls of Guildford long had the patronage. It has some, but not considerable manufactures, and depends chiefly on the numerous villages around it, which send their agricultural productions to the market every Thursday. The inhabitants in 1801 amounted to 2755, in 1811 to 2841, and in 1821 to 3396.

BANCA, an island in the Eastern Seas, about 130 miles in length by forty or fifty in breadth, lying off the north-eastern coast of Sumatra, from which it is separated by the Straits of Banca. This island has in all ages been celebrated for its mines of tin, which have yielded immense quantities of ore, and appear to be inexhaustible. They were discovered about the year 1710, and are worked by a colony of Chinese, who are said to amount to 10,000. These miners, from long practice, have arrived at such perfection in reducing the ore into metal, employing wood instead of coal in their furnaces, that the tin of the Banca mines is preferred to European tin in the market of Canton, as being more malleable. From 133 pounds of ore are obtained seventy-five pounds of metal. This island is opposite the river of Palembang, in the island of Sumatra, and it belonged to the sovereign of the district of Palembang, who exacted from the proprietors of the mines a certain quantity of its produce at a fixed price, which he re-sold to the Dutch at a small advance of profit. The island was ceded to the Dutch in 1812, in consequence of an expedition against its sovereign, which was sent from Batavia. A fort was erected two miles west of a small town called Minto; but the situation proved so unhealthy that it was afterwards removed to a more inland spot. By the convention concluded in 1814, Banca was ceded to the Dutch. The miners and some pirates were formerly its only inhabitants. The Straits of Banca are formed by the island of Sumatra on the west, and that of Banca on the east. They are about 100 miles in length, of unequal breadth, and the depth of water very irregular, shoaling in some places at once from twelve to seven fathoms. The tide rises and falls about eleven feet. Long. 105. 15. to 106. 40. E. Lat. 1. 27. to 3. 4. S. Another small island of this name, amid a cluster still smaller, lies off the north-east extremity of the island of Celebes.

BANCAPOOR, a large town of Hindostan, in the province of Bejapoor, and formerly a place of importance. The fort was dismantled by Tippoo's army. It is 50 miles S.S.E. from Darwar. Long. 76. 16. E. Lat. 14. 58. N.

BANCOOK, a sea-port of the kingdom of Siam, situated on the east side of Siam river. It is properly the sea-port of Siam, few ships ascending higher up the river; and it is distant from it forty-two miles. In the reign of Louis XIV. this place was ceded to the French, who here erect-

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ed a fortress, which they retained for several years. They were afterwards expelled from the country about 1690, and have never since recovered their influence in it.

BANDA ISLANDS. These islands, situated 130 miles to the south-east of Amboyna, are ten in number, viz. Banda Neira, Gonong Apee, Banda Lantoir, Pulo Ay or Way, Pulo Rondo or Pulo Roon, Rosyngen, Pulo Pisang, Craka, Capella, and Sonangy.

Of these, Banda Neira is the seat of the supreme government, and it is secured by one principal fortification, situate on the south side of the island, consisting of a small square fort, having a wet ditch, with a horn-work towards the sea. This fortification, which is called Fort Napau, forms the chief defence of the Banda Islands. The troops are quartered, and the public granaries are kept, in this fort; but the storehouses for the nutmegs and mace are on the outside, as well as the government-house. Above Fort Napau, on a neighbouring eminence, stands the castle of Belgica, an old pentagon, with round towers at the angles. It is surrounded with a wall, secured by small bastions, but has no ditch, and is said to have been built by the Portuguese.

Banda Lantoir or Great Banda is to the northward of Banda Neira. It is commanded by a considerable fort, which also domineers over the harbour, and is called Fort Hollandia. At first view the situation of this fort appears preferable to Banda Neira for the residence of government, not only on account of its strong and commanding situation, but because the island is the largest as well as the richest in the produce of spices. Its unhealthiness has been found, however, to be a sufficient objection. The water is said to be bad, and the vapour which sometimes descends from the volcanic mountain of the neighbouring island, Gonong Apee, is represented as particularly noxious. Such fatal effects were produced by these causes, that when the Wirtemberg Company formerly garrisoned the island, out of a hundred men eight died and forty fell sick in the course of two months. The numbers of decayed houses, also, which are seen in different parts of the island, show that the experiment of a settlement has already been tried, and has not been found to answer. This island appears very high from the sea; its sides are steep, and from the top of them there is a sort of table-land, which extends nearly from one end of the island to the other.

Gonong Apee is to the northward of Banda Neira, and derives its name from a large volcano about 2000 feet above the level of the sea, which constantly emits smoke, and sometimes cinders and ashes, accompanied with a crackling noise. On the south side of this island are two forts, originally intended to defend the west channel of Lantoir harbour; but, owing to an eruption of the volcano in 1778, at the same time that a dreadful hurricane laid waste the island, the lava flowed down in such quantities as to form a considerable promontory between these batteries and the channel they were intended to defend, so that they are now in a great measure useless. This island is generally unproductive, its surface being covered with a quantity of sulphur and chalk. There is no vegetation whatever on upwards of one third of the eminence on which the volcano is situated. Towards the sea the descent is exceedingly steep; but towards the harbour the declivity slopes gradually to the water, on the side of which are some plantations and a few straggling houses.

Pulo Way is about nine miles to the westward of Gonong Apee, and is defended by a strong fort. It is esteemed the most healthy of the whole group, and produces abundance of nutmegs, of a kind superior in quality to those of the other islands. Pulo Rondo, or Pulo Roon, is about four miles farther, in a somewhat more northerly direction. On this island the English had a factory, from

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which they were expelled by the Dutch about the period of the massacre of Amboyna; and the island having been since abandoned, has become a wilderness. Rosyngen is about seven miles to the south-east of Lantoir. It produces nutmegs, mace, yams, and subsistence for a few cattle. The convicts of Amboyna were formerly kept on this island, and were compelled to cultivate the land for the use of the supreme government. Pulo Pisang is about two miles north-east from Banda Neira, and yields some fine fruits, as well as nutmegs and mace. The other three islands are uninhabited, being little more than barren rocks.

The Banda Islands were discovered in the year 1511 by the Portuguese, who immediately took possession of them in the name of their sovereign. About the year 1603 they were expelled by the Dutch. In 1608 the English, with the permission of the king, built a factory-house on Pulo Way, which the Dutch demolished as soon as the ship which brought out the factors returned to England. The natives of Banda, notwithstanding the opposition of the Dutch, assisted the English in forming a new colony; and shortly afterwards they, along with the natives of Lantoir, made a formal resignation of their respective islands to the new settlers. In 1620 Pulo Roon and Pulo Way were added to the English dominions, and these cessions were confirmed by a treaty concluded between the English and the Dutch. But, in defiance of this treaty, the latter determined on the expulsion of their rivals from those islands, in the possession of which they appeared to be gradually establishing themselves. They accordingly attacked them with a strong force, seized their factories, magazines, and shipping, and, after stripping the factors naked, first whipped and then loaded them with irons. Some notion may be formed of the trade, then in its infancy, by the quantity of spices seized here, which amounted to 23,000 lbs. of mace and 150,000 lbs. of nutmegs. In 1654 the Dutch were compelled, by the firmness of Cromwell, to restore the island of Pulo Roon, and to make satisfaction for the massacre of Amboyna. But the English settlers not being adequately supported from home, were unable to resist the power of their rivals, and the island was retaken by the Dutch in 1664. They retained undisturbed possession of their conquests in this quarter of the globe until the year 1796, when the Banda Islands, along with all the other Dutch colonies, were conquered by the British. They were restored by the treaty of Amiens in the year 1800, but were again captured, and finally restored by the treaty of Paris concluded in the year 1814.

In the space between Banda Lantoir and the islands of Banda Neira and Gonong Apee there is a very good harbour formed with entrances both from the east and west, which enable vessels to enter it from either of the monsoons. These channels are well defended with several batteries, particularly the western one, which is very narrow. Between Gonong Apee and Banda Neira there is a third channel into this harbour from the north, but it is navigable only for small vessels.

The great articles of commerce in these islands are nutmegs and mace, which are engrossed at a fixed price, for the benefit of the Dutch East India Company; and the laws and regulations generally established are calculated to support and promote this monopoly rather than the happiness of the people or the improvement of the country. With this view, the cultivation of the nutmeg is only allowed in the islands of Banda Neira, Gonong Apee, Banda Lantoir, and Pulo Ay. In all the other islands the tree has been carefully extirpated, because, being at a distance from the seat of government, they were supposed to afford better opportunities for smuggling. In the islands which

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are appropriated to the cultivation of the nutmeg, they neither feed cattle nor produce grain sufficient for the maintenance of the inhabitants; and they are on this account dependent on Batavia for annual supplies of rice, and other articles of provision. In consequence of the low state of agriculture occasioned by this policy, the inhabitants are few, and the number of hands that would be necessary to bring the nutmeg plantations into the highest state of cultivation cannot be procured. This scarcity of hands renders it necessary to recruit the declining population by the importation of slaves. It would appear, also, that the inhabitants suffer severely when the supplies of provisions, on which they depend from abroad, happen to be interrupted. About fifteen months before these islands were last conquered by the British, some reforms in the system of administration were carried into effect by a new governor, who had been appointed for that purpose. But before this period most of the planters were in great distress, having been charged with very heavy debts, incurred on account of loans in rice and money, made at different periods by the former governors; and this circumstance, joined to the great loss which they sustained by the dreadful hurricane of 1778, entirely ruined their private fortunes as well as their plantations. While they were in these distressed circumstances, the Dutch government, with an unfeeling avarice, aggravated their misery by compelling them to deliver their nutmegs at the reduced price of three farthings per pound, and the mace at a still lower rate. Under this accumulated distress, the spirit which had animated their fathers in the days of their independence seemed once again to revive, and they remonstrated in bold and determined language. They claimed the lands as their own prescriptive inheritance, which was undoubtedly the case, and actually proceeded to portion out their respective properties to each other. The Dutch, though they were touched by no feeling for the deplorable situation to which they had reduced the country, were nevertheless alarmed when they saw their discontented subjects determined to resist, and it was thought advisable to adopt a more just and conciliatory conduct. With this view, the accumulated arrear of debt claimed by the company from the planters, and which most of them were unable to pay, was cancelled. Several judicious regulations were also adopted regarding the management of slaves, and the prices at which the government received the spices of the planters were at the same time increased from the low rate to which it had been reduced to seven and a half stivers per lb. for mace, and to two and a half stivers for nutmegs, with a deduction of 17 per cent. in favour of the company and their servants.

In return for these concessions, it would appear that the company, after having pacified their subjects, seized their lands; and in this manner they continued to practise the same oppression as before, though the mode adopted was somewhat different. The planters in general, if they had once been freed from the enormous debt claimed by government, would, from the produce of their plantations, have speedily discharged all other claims; and they considered it hard, therefore, that, under colour of remitting this debt, they should be deprived of their respective properties, to which prescription gave them an undoubted right.

The nutmeg-tree is a native of several of the islands to the eastward; but it has been in a great measure extirpated from all of them except Banda. It begins to bear fruit at ten years' growth, the fruit improving in quality, and increasing in quantity, until the tree has attained the age of an hundred years. In its appearance it is handsome and spreading; the bark is smooth, and of a brownish gray colour. The leaves resemble those of the laurel, and af-

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ford, when bruised, a grateful aromatic odour. When the tree first begins to produce fruit, little yellowish buds make their appearance, out of which small white flowers are blown, two or three hanging upon slender peduncles. In the centre of the flower is an oblong reddish knob, from which the fruit is produced, though no more than one blossom out of three commonly ripens to a nutmeg. It is eight or nine months before the fruit arrives at maturity; but blossoms and ripe fruit are found together on the same tree, and the nutmegs are generally gathered three times in a year. The nutmeg, when ripe on the tree, has a very curious and beautiful appearance. It is almost the size of an apricot, and nearly of the same colour, with the same kind of hollow mark all round it. In shape it is somewhat like a pear. When perfectly ripe, the rind over the mark, which is nearly half an inch thick, and of a whitish colour, opens and displays the nutmeg in its black and shining shell, encircled by a net-work of scarlet mace. The shell in which the nutmeg is inclosed is about as thick as that of a filbert, and very hard. In preparing the fruit for use, the mace is first stript off and kept in baskets to dry in the sun, and the nutmeg in its shell is placed before a slow fire to dry, in five different houses made of split bamboos, fitted up for the purpose. In each of these houses it remains a week, till it is heard to shake within the shell, which is then easily broken. The nutmegs thus prepared are sorted into separate parcels. Each sort is put up by itself into baskets, and soaked three times in tubs of sea-water and lime; after which they are put into distinct closets, where they are left for six weeks to sweat, that the lime, by closing the pores of the nutmeg, may prevent its strength from evaporating. The lime is necessary to preserve the fruit from worms and other insects; and it requires much experience, as well as a considerable degree of judgment, to ascertain the precise time that the fruit should be suffered to remain in the lime; for if it be taken out too soon, it is worm-eaten, and if it is left to remain too long in the lime, it is burnt up and rendered useless.

The nutmeg is distinguished into three sorts, namely, the male or barren nutmeg, the royal nutmeg, and the queen nutmeg. The two last species are distinguished by the different sorts of fruit which they produce, that of the royal nutmeg being longer and more pointed, and its green shell being also thicker. It does not ripen so fast; and after opening it preserves its freshness eight or nine days. The mace is more substantial and three times as long as that of the queen nutmeg, and its stripes or thongs, of which there are from 15 to 17 principal ones, are of a livelier red; they are also broader, longer, and thicker, and not only embrace the nut through its whole length, but pass it, and cross under it as if to prevent it from falling. The royal nutmeg is generally from 15 to 17 lines long, and thick in proportion. It remains on the tree a long time after the opening of the green shell, and gives birth to an insect in the shell, which feeds upon and destroys it. The queen nutmeg produces much smaller nuts, only nine or ten lines long, not so thick by a third, and well marked by a longitudinal groove on one side. They are round, and the green shell is not so thick as that of the royal nutmeg. The mace, which is composed of nine or ten principal stripes, grows only half down the nut; thus leaving it at liberty to detach itself, and to escape from the insect formed in the shell. In two or three days also the green shell, losing its freshness, soon falls away from the nut.

Nutmegs should be chosen large, round, heavy, and firm; of a lightish gray colour on the outside, and the inside finely marbled; of a strong fragrant smell, warm aromatic taste, and a fat oily body. The oblong kind and smaller

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ones should be rejected. The real quantity of nutmegs produced has never been exactly ascertained. The largest quantity sold by the Dutch East India Company at one time was 280,694 lbs. in the year 1737. In 1756 there were sold 241,427 lbs.; and in 1778, 264,189 lbs. The average quantity annually sold in Europe has been stated at 250,000 lbs. exclusive of about 100,000 lbs. disposed of in the East Indies. The produce, however, has since greatly declined, which may be imputed to various causes. In the year 1778 the nutmeg plantations were laid waste by a tremendous hurricane; and this calamity was succeeded by oppressions on the part of the government, and by disturbances among the people. Agriculture and industry were in consequence neglected, and the annual produce of spices of all sorts, which amounted to 600,000 lbs. was suddenly reduced to 50,000 lbs. For seven years previous to the commencement of the war with France in 1793, the average quantity of nutmegs sold in Holland amounted only to 22,459 lbs. and that of mace to 7504 lbs. When Banda was taken by the English in 1796, the quantity of spices in the warehouses amounted to 84,777 lbs. of nutmegs, and to 19,587 lbs. of mace. In the several years of 1803, 1804, and 1805, when the Banda Islands were in possession of Britain, there were imported of nutmegs 104,094, 117,936, and 35,851 lbs., which were sold for L.46,233, L.54,733, and L.23,742. The quantity retained for home consumption amounted on an average to 39,071 lbs. per annum, and the revenue which they yielded to L.7879. The permanent duty levied on nutmegs imported from any British possessions is 2s. 6d. per lb., and from other parts 3s. 6d. per lb.

Of mace, the quantity consumed in Britain has decreased since the establishment of the East India Company. In the year 1615, the consumption amounted to 15,000 lbs. In 1803, when the islands were in possession of Britain, the whole quantity amounted only to 24,234 lbs., and the total value was L.53,356. The quantity retained for home consumption is on an average about 5400 lbs. per annum. The duty on mace imported is 3s. 6d. per lb. when imported from any British colony; from other parts it is 4s. 6d. Mace should be chosen fresh, rough, oleaginous, of a fragrant smell, and a bright reddish yellow colour. The smaller pieces are esteemed the best. (See Milburn's *Oriental Commerce*, and the *Asiatic Annual Register*.) (F.)

BANDALEER, or BANDELIER, in military affairs, a large leathern belt, thrown over the right shoulder, and hanging under the left arm. It was worn by the ancient musketeers, both for sustaining their fire-arms, and for the carriage of their musket charges, which, being put up in little wooden cases coated with leather, were hung, to the number of twelve, to each bandaleer.

BANDELLO, a celebrated Italian novelist, was born at Castelnuovo, in the neighbourhood of Tortona, about 1480. In his youth he studied both at Rome and at Paris; and his education being completed, he went to reside at Mantua. There he remained for several years much esteemed by Pirro Gonzaga, who intrusted him with the education of his daughter, the celebrated Lucrezia Gonzaga. The incidents in the lives of the literary men who flourished in Italy during the sixteenth and seventeenth centuries have in many respects a strong similarity. Like most of his literary contemporaries, Bandello passed from one petty court to another, and was frequently employed in political missions by the patron whom he served at the time. At this period the small states of Italy were divided between the French and Spanish interests. Bandello had chiefly attached himself to those princes of Lombardy who favoured the French party; and, in consequence, when the decisive battle of Pavia put the Spaniards in possession of Milan, where Bandello at that time

resided, his paternal mansion was burned, and the property of his family confiscated. He fled in disguise from Milan, and after wandering from town to town, he placed himself under the protection of Cesar Fregoso, a celebrated captain of that age, who had recently quitted the Venetian for the French service. With this general Bandello resided in Piedmont, till a truce was concluded, when he accompanied his patron to France. After the death of Cesar he continued to live with his widow and family at Agen, to the bishoprick of which he was raised by Francis I. in 1550, and continued to reside in the vicinity of that town till his death, which happened about 1562.

During his residence at Agen, Bandello revised and added to the novels which he had written in Italy during his youth, and which some of his friends had recovered from the hands of the Spanish soldiers who burned his house at Milan. His *Tales* were first published at Lucca in 1554, 4to. In the complete editions of Bandello, the work is divided into four parts; the first, second, and third parts containing fifty-nine stories, and the fourth comprehending twenty-eight. The whole are dedicated to Ippolita Sforza, though she died before their publication, because it was at her desire that the work was originally undertaken. Besides this general dedication, each novel is addressed to some *Valoroso Signore*, or *Chiarissima Signora*; and in these introductions the novelist generally explains how he came to a knowledge of the event he is about to relate. He usually declares that he heard it told in company, details the conversation by which it was introduced, and pretends to report it, as far as his memory serves, in the exact words of his authority.

Bandello is chiefly indebted for his celebrity to these novels, which belong to a class of composition that enjoyed for many centuries the utmost popularity in Italy. The tales of the French Trouveurs, having passed into Italy towards the close of the thirteenth century, were first imitated in the *Cento Novelle Antiche*; which also contains stories formed from episodes in the romances of chivalry, the ancient chronicles of Italy, and jests or repartees preserved by oral tradition. Boccaccio, whose *Decameron* appeared shortly after, identified this species of composition with the history of Italian literature and the progress of the Italian language. That celebrated writer was followed by Sacchetti, Ser Giovanni, Centio, and a numerous tribe of imitators, of whom Bandello is by much the best known and most celebrated, at least in this country. His popularity, however, has not been so great in Italy, which may probably be attributed to the negligence and impurity of his style; a fault of which the author himself appears to have been conscious, as he repeatedly apologizes for his defects in elegance of diction. *Io non sono Toscano, nè bene intendo la proprietà di quella lingua; anzi mi confesso Lombardo.* Napioni, in his eulogy of Bandello, confesses that he is not remarkable for that harmony of periods, and delightful *naïveté* of expression, for which Boccaccio and others of his predecessors were so distinguished; but he adds, that none of the Italian novelists is so interesting for the development and illustration of minute historical facts, which would in vain be sought for in the histories of the revolutions of the Italian states. Some of the novels of Bandello, however, it must be admitted, are little edifying; and it is curious that one of his stories, which is perhaps the most obscene in the whole series of Italian novels, should be declared, in the introduction, to have been related by the celebrated Navagero to the princess of Mantua and duchess of Urbino. Besides, notwithstanding the repeated assertions of Bandello, that all his stories have some foundation in fact, and the light which his eulogists suppose that they throw on the history of the Italian republics, it cannot be

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denied that the greater proportion of them are derived from the Fabliaux of the French Trouveurs, and the works of preceding Italian novelists, with an alteration of the names, and some slight variations in the incidents. But while Bandello has thus copied largely from preceding fablers, none of their works has suggested more to others, or is more curious for illustrating the genealogy of fiction, and the transmission of fabulous incident from the novelist to the dramatic poet. Many of the tales of Bandello were translated by Belleforest in his *Histoires Tragiques*, whence they found their way into Paynter's *Palace of Pleasure*, and other works of a similar description which appeared in England during the reign of Queen Elizabeth. In this manner they furnished the plots of many tragedies and comedies to the most numerous and noble race of the English dramatic poets. That part of Shakspeare's *Much Ado about Nothing* which relates to Don John, Claudio, and Hero, is taken, with little variation in the incidents, from the twenty-second tale of the first part of Bandello; and *The Twelfth Night* is borrowed from the thirty-sixth of the second part. Massinger has been indebted for his *Picture*, which is, perhaps, the most agreeable and fanciful of his dramas, to the twenty-first of the first part; while Beaumont and Fletcher have derived from the same source their comedy of the *Maid in the Mill*, and the *Triumph of Death*, which is the third of their "Four Plays in One." The thirty-fifth of the second part of Bandello is the same story as the plot of Horace Walpole's *Mysterious Mother*, and the thirtieth tale of the Queen of Navarre. As the works of Bandello and the Queen of Navarre were printed nearly at the same period, it is not probable that they copied from each other; and it may be presumed, that some current tradition furnished both with the horrible incident they relate. Mr Walpole, however, disclaims having had any knowledge of the tale of the Queen of Navarre or Bandello at the time he wrote this drama. Its plot, he says, was suggested by a story he heard when very young, of a lady, who, under uncommon agonies of mind, had waited on Archbishop Tillotson, and besought his counsel in what manner she should act under the fatal circumstances that had occurred. Besides his *Tales*, Bandello is author of a poem in eleven cantos, which was his first work, and is now very scarce, entitled *Delle Lodi della Signora Lucrezia Gonzaga*, printed at Agen, 1545, in 8vo. He also wrote a complimentary poem, in three cantos, on the birth of a son of his patron, Cesar Fregoso. Both these productions are written without taste or spirit; but it is said that some good verses, composed by Bandello, on different subjects, are still preserved in manuscript in the library of the academy of Turin. (q.)

BANDER CONGO, a small sea-port town in Asia, seated on the Persian Gulf. Long. 54. 10. E. Lat. 19. 0. N.

BANDINI, ANGELO MARIA, a learned Italian, was born at Florence on the 25th of September 1726. Having been left an orphan in his infancy, he was supported by his uncle, Joseph Bandini, a lawyer of some note. He received his education among the Jesuits, and discovered an early passion for the study of antiquities. A desire which he also manifested to distinguish himself as a poet was fortunately checked by the ill success of his first attempt; and, from that period, he devoted himself principally to literary history and archæological science. The celebrated Dr Lami, with whom he had the good fortune to contract a friendship, assisted him with his counsels, and encouraged him to persevere in that path to which his genius seems to have directed him.

In the year 1747 Bandini undertook a journey to Vienna, in company with the bishop of Volterra, to whom he acted in the capacity of secretary. He was introduced to

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the emperor, and took the opportunity of dedicating to that monarch his *Specimen Litteraturæ Florentinæ*, which was then printing at Florence. In the following year he returned by the way of Venice, Padua, Ferrara, and Bologna, and united himself in friendship with the learned men in all these cities. Having resided some time at Florence, he repaired to Rome, and entered into orders, passing the whole of his time in the library of the Vatican, and in those of the Cardinals Passionei and Corsini. At that time the famous obelisk of Augustus was disinterred from the ruins of the *Campus Martius*. Bandini, by the order of Benedict XIV., undertook to describe and explain this curious monument; but finding that the air of Rome was injurious to his health, he returned to Florence. In 1750 he was selected by Alexander Marucelli to take charge of the valuable library which his uncle the Abbé Francis Marucelli had left, and which, according to the will of the founder, was to be open to the public. But he had scarcely entered upon the duties of this charge when the proprietor died, after bequeathing all his effects to the library, and appointing the Abbé Bandini perpetual librarian and his testamentary executor. It required two years to liquidate the succession and to form the complete catalogue of this vast library, which was at length opened to the public in the year 1752. In 1756 he was preferred by the emperor to a prebend at Florence, and appointed principal librarian to the Laurentian library. During forty-four years he continued to discharge the duties of this situation, and died in 1800, generally esteemed and regretted. On his death-bed he founded a public school, and bequeathed the remainder of his fortune to other charitable purposes.

The first work by which Bandini became known as a man of letters was his *Dissertatio de Veterum Saltationibus*, which he wrote at the age of twenty-two, and which was inserted by his learned friend Lami in the fifth volume of the works of Meursius, published in 1745. The most remarkable of his other works are, 1. *Specimen Litteraturæ Florentinæ Seculi XV. &c.* 2 vols. 8vo. 2. *De Obelisco Augusti Cæsaris, e Campi Martii Ruderibus nuper eruto.* 1750, fol. 3. *Collectio Veterum aliquot Monumentorum ad Historiam, præcipue Litterariam, pertinentium.* 1752, 8vo. 4. *Elogio dell' ab. Francisco Marucelli Fondatore della Publica Libreria Marucelliana.* 1754, 4to. 5. *Vita e Lettere di Amerigo Vespucci.* 1745, 4to. 6. *De Vita et Scriptis Joan. Bapt. Donii Patricii Florentini libri V. Adnotationibus illustrati; accedit ejusdem Donii litterarium commercium, nunc primum in lucem editum.* 1755, fol. 7. *Vita di Filippo Strozzi.* 1756, 4to. 8. *Vita del Cardin. Niccolo da Prato.* Eod. an. 4to. 9. From 1763 to 1766 he employed himself in publishing successively the works of some of the minor Greek poets, which he enriched with notes and various readings. These were Callimachus; the two poems of Nicander on Poisons and Antidotes; the Phenomena of Aratus; the Poems of Musæus; those of Coluthus on the Rape of Helen, and Tryphiodorus on the taking of Troy; Theognis, Phocylides, and the golden verses of Pythagoras. The Greek text of these poems was carefully collated with the best manuscripts; and there were added translations in Italian verse by Ant. Mar. Salvini. 10. *Catalogus Codicum Manuscriptorum Græcorum, Latinorum, et Italicorum, Bibliothecæ Laurentianæ.* 1764-78, 8 vols. fol. 11. *Bibliotheca Leopoldina Laurentiana, sive Catalogus Manuscriptorum, qui jussu Petri Leopoldi in Laurentianam translati sunt.* 1791-93, 3 vols. fol. 12. *De Florentini Juntarum Typographia, ejusque censoribus.* 1791, 2 parts, 8vo. (See *Biographie Universelle*, tom. iii.) (k.)

BANDITTI, from the Italian *bandito*, persons proscribed, or, as we call it, outlawed, and sometimes deno-

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Banffshire.

minated *banniti* or *foris banniti*. It is also a denomination given to highwaymen or robbers who infest roads in troops.

BANDON, or BANDONBRIDGE, a town of Ireland, in the county of Cork, on the river Bandon, which flows into the sea at Kinsale. Its public buildings are two churches, a handsome Roman Catholic chapel, and a court-house. It has two market-houses and a spacious quay on the south side of the river. It has manufactures of linen, camlets, and coarse woollen stuffs; also tanneries, breweries, and dye-works. The population is 10,179. It is 18 miles S. W. of Cork.

BANDORA, the capital of the island of Salsette, on the western coast of the peninsula, on this side the Ganges. Long. 72. 30. E. Lat. 19. 0. N.

BANDORE, the name of a musical instrument with strings, resembling a lute, and said to have been invented in the fourth year of Queen Elizabeth, by one John Rose.

BANDROL, a little flag, in the form of a guidon, extended more in length than in breadth, and usually hoisted on the masts of vessels; a pennant or streamer.

BANE, from the Saxon *bana*, a murderer, signifies destruction or overthrow. Thus, "I will be the *bane* of such a man," is a common saying: when a person receives a mortal injury by any thing, we say, "it was his *bane*:" and he who is the cause of another man's death is said to be *le bane*, that is, a malefactor.

BANFF, the capital of Banffshire, is situated on the western bank of the Deveron, at the point where that river discharges itself into the sea. It was constituted a royal burgh by Robert II. in 1372, and its charter was confirmed by the succeeding princes of the Stuart dynasty. The town is remarkably neat, and contains several well-built streets. The buildings, though in general antique in their appearance, comprise several very respectable modern structures, amongst which are the town-house which is surmounted by an elegant spire, a fine new church, a handsome Episcopal chapel, and an academy. It possesses a harbour, which is very indifferent, and not much visited by shipping. The exports consist principally of salmon, herrings, and other fish. The manufactures are inconsiderable, being confined to thread, linen, stockings, soap, and tanning. The Deveron is crossed at this place by a handsome bridge of seven arches, which affords communication with a modern sea-port called Port Macduff, a place possessing considerable trade. The town suffered severely from the inundation of 1829, a number of the houses having been undermined and swept away. Banff has a weekly market, and four fairs annually. By the census of 1831 the population of the town and parish amounted to 3711. It is distant 44 miles N. W. from Aberdeen, and 165 N. from Edinburgh. Long. 2. 25. W. Lat. 57. 38. N.

BANFFSHIRE, a county in the north of Scotland, bounded by the Moray Frith on the north, by Aberdeen-shire on the south and south-east, and by the county of Moray on the west, is situated in the 58th degree of north latitude, and between 2° 13' and 3° 40' west longitude. It contains 647 square miles, or, exclusive of a small space covered with water, 412,800 English acres. Along the coast for about thirty miles the soil consists chiefly of sand and loam, and is well cultivated; but, with the exception of this track, Banffshire is a hilly, and, towards the south, a mountainous district, though many fertile valleys are interspersed. There is, however, much valuable grazing land, well sheltered with natural wood, particularly on the banks of its streams, and in its romantic glens. The Spey, one of the most considerable rivers in Scotland, flows along its western, and the Deveron along its eastern boundary; and both yield a considerable revenue from their salmon-fishings,—the former to the amount of L.8000, and the latter to about L.2000 yearly. The principal mountains of Banffshire

are Belrinnes, Knockhill, and Cairngorm, the last of which Banffshire rises to an elevation of 4050 feet above the level of the sea. In the lower part of the country, towards the coast, there are several elegant mansions, of which the most conspicuous are Duff-House, the principal seat of the family of Fife; Cullen-House, the seat of the Earl of Findlater and Seafield; and Gordon Castle, the most princely mansion in the north of Scotland. These, and a number of gentlemen's seats in the interior, are surrounded by extensive policies or ornamental plantations, very tastefully laid out. The natural woods are inconsiderable both in extent and value.

Many of the mountains are caped with moss, regularly stratified, and containing the remains of plants, trees, and vegetables. Some there are the tops of which are formed of granite, protruding through thick beds of gneiss passing into mica slate. The prevailing rocks throughout the county are granite, gneiss, graywaké, graywaké slate, quartz rock, sienite, trap rock, old red sandstone, mica slate, clay slate, primitive transition rock, and new formation lime-stone. The direction of the strata is from north-east to south-west. Few of the primitive rocks appear stratified. The hill of Durn, adjacent to Portsoy, is wholly composed of stratified quartz, which appears to lie on a thick bed of gneiss, along the eastern side of which runs, in a south-westerly direction from Portsoy, a vein of beautiful serpentine. The bold and precipitous rock of Troup Head, 470 feet in height, consists of graywaké. At the farm house of Findon, near Gamrie, is a bed of breccia, composed of angular fragments of clay slate and indurated clay, resting on a bed of red sandstone. Petrified fish or ichthyolites, imbedded in calcareous nodules, have lately been discovered. To the westward of Whitehills there is a bed of transition lime-stone, alternating with graywaké, graywaké slate, and coarse gritstone, imbedded in a lime-stone paste. To the eastward of Portsoy is found a bed of that peculiar structure called graphic granite; near Keith is a vein of sulphuret of antimony, embedded in fluor spar; and about a mile to the westward of Banff is a bed of blue clay, containing a variety of organic remains. Rock-crystals and topazes are found on the mountains of Cairngorm, and other parts of that elevated range which forms the southern and western boundaries of Banffshire. Cudbear, or more properly archil, though a vegetable substance, may be mentioned after the minerals, from its growing only in rocky mountainous situations. Its use in dyeing purple, after undergoing a simple preparation, is said to have been discovered before the year 1755, by Mr Gordon, a gentleman of the parish of Kirkmichael, in this county.

The agriculture of Banffshire is upon the newest and most approved principles. The soil, though varying even in adjacent fields, is in general rich and productive, yielding heavy crops of wheat, barley, oats, and other grain; and the grass and green crops are equally abundant. The quantity of soil under cultivation has never been properly ascertained, but it may safely be affirmed that the amount now under the plough is more than double of what it was thirty years ago. The extent of the farms is in general from 150 to 200 arable acres, independently of moorland and pasture grounds. The rent per acre, at an average, may be stated at 22s., and the duration of leases at nineteen years; although there are some who possess on life, and a few who hold leases for a longer term. The whole of the farms, even the smallest pendicles, are under regular rotations of cropping, generally a five or seven years course. The fields are well laid out and subdivided, and properly cleaned and manured, for which last purpose large quantities of lime and bone dust are annually imported; but lately some successful experiments have been tried with prepared kelp as a substitute for bone dust, which can now be but partially procured, and at a

Banffshire very high price. The ridges are all straight, and the fields, at least many of them, are inclosed with stone dykes or other fences; the swamps and wet grounds have also been drained and cultivated, so as to effect a total revolution in the ancient modes of agriculture within the county. The cattle and stock of every description are of the finest breeds which can be procured, and are sought after by the dealers at home, as well as conveyed by sea to London, where they always bring the highest prices of any in the market.

This district was much indebted to one of the earls of Findlater, who, as early as the year 1754, not only introduced and exemplified on some of his own farms the most approved practices then known in England, but held out liberal encouragement to his tenants to follow his example: And, latterly, improvement has been promoted by agricultural associations, and the annual premiums held out for the best specimens of live stock, and the best productions of the soil. The valued rent is L.79,200 Scots; and in 1811, according to the assessment for the property tax, the real gross rent of land amounted to L.79,396. 3s. 4d., and that of houses to L.5514. 2s. sterling.

The entailed properties, comprehending almost the whole lands within the county, are fettered with restrictions and limitations which prove a very heavy grievance to the tenant, checking industry and improvements, and limiting the duration of the lease frequently to a very short period. Astricted multures, which still prevail in this county in all their ancient feudal vigour, are also particularly oppressive; being a tax on improvement and industry, amounting in some instances to a yearly payment of one eighth part of the whole crop.

The manufacturing industry of this county is considerable. An iron-foundry was established at Banff in 1825, and has proved of great utility, particularly to agriculture, in supplying the requisite machinery and implements. There are also a number of extensive distilleries which produce excellent spirits, and a small bleachfield at Cullen. The shipping trade is carried on at the ports of Banff, Macduff, Portsoy, and Gardenstown. The imports consist of timber, coals, iron, and other necessary articles. The exports from June 1830 to June 1831 consisted, of grain 65,000 quarters, of meal 740 tons, of black cattle 276 head, and upwards of 1000 swine, besides some horses and other live stock, all principally for the London market. Salmon and other fish are also exported in considerable quantities; and a very extensive connection has been formed with various ports on the southern shores of the Baltic,

to which vast numbers of cured herrings are sent. In Banffshire 1815 there were only two boats of fifteen tons each employed in the herring trade, but in 1826 they amounted to 470 of the same tonnage each, and the value of the fish caught was estimated at nearly L.100,000 sterling. Cod, ling, haddocks, and other white fish are also caught in considerable quantities, and to a great amount in value.

Banffshire was the scene of many bloody conflicts between the Scots and their Danish invaders, in which the latter were uniformly defeated, and driven back to their ships, without effecting a permanent footing in the country. From the year 1624 to 1645 it was the theatre of almost incessant struggles. During that period, the outrages of the covenanters and their opponents, combined with the frequent conflicts of the clans, threw a dark shade over its annals. Many parts of Banffshire are distinguished for their picturesque and sublime scenery. At the mouth of the Moray Frith, the two promontories, Troup-head and Pennau-point, throw their gigantic masses over the waters. Far off appears the residence of that distinguished lawyer Lord Gardenston. Near this is the celebrated church of Gamrie, the "Kirk of Sculls," into the walls of which were built the bones of the Danes who fell in the field called Bloody Pots. This edifice was used as a place of worship till 1830, a period of above 820 years from the date of the erection. Nearer still is the old church and manse of Pitsligo, surrounded by a few beautiful trees, and like a "diamond in the desert," compared to the sterility around; and lastly, among these iron rocks is a small narrow hole, opening from the wide ocean, in which was concealed for a long time that virtuous follower of the pretender, the good and venerable Lord Pitsligo. Several remains of antiquity are pointed out in different parts of the country. Of these the churches of Mortlach on the mountains, and Gamrie above mentioned, are perhaps the most remarkable. Ruins of castles and traces of encampments are often to be met with, and a great number of cairns and tumuli are also found. Amongst the distinguished men which Banffshire has produced may be mentioned Archbishop Sharpe of St Andrews; George Baird, distinguished for his services as sheriff of the county during the time of the covenanters; Thomas Ruddiman the grammarian; Walter Goodall, the defender of Mary Queen of Scots; James Ferguson the astronomer; and Dr Gregory, and his brother James Gregory.

The population, as taken under the acts of 1811, 1821, and 1831, is given in the table below.

YEAR.	HOUSES.			OCCUPATIONS.			PERSONS.		
	Inhabited.	By how many Families occupied.	Uninhabited.	Families chiefly employed in Agriculture.	Families chiefly employed in Trade, Manufactures, or Handicraft.	All other Families not comprised in the two preceding classes.	Males.	Females.	Total of Persons.
1811	8043	8612	223	3815	2195	2602	16,465	20,203	36,668
1821	8971	9885	210	4150	2939	2796	20,193	23,368	43,561

In 1831 the population was as follows:—Families, 10,855; males, 22,743; females, 25,861; total, 48,604.

BANGALORE, a fortified town of Hindostan, in the rajah of Mysore's territories, founded by Hyder. The fort, which was constructed by Hyder after the best fashion of Mahomedan architecture, was destroyed by his son Tippoo, after he found that it was incapable of effectually resisting the British army. It was afterwards repaired in 1802. The gardens made here by Hyder and Tippoo are extensive, and, owing to the height of the ground, the town being

by observation 2901 feet above Madras, European fruits and plants may be reared. During the reign of Hyder this city was populous, but was much injured by the edicts of Tippoo, prohibiting all trade with the dominions of Arcot and Hyderabad, and by his forcing the merchants to buy from him a large quantity of goods at a high price. To complete its misfortunes, the town was stormed by the British troops under Cornwallis, and abandoned to

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Banians.

plunder. The travelling distance from Seringapatam is 74 miles, from Madras 215, and from Hyderabad 352. Long. 77. 46. E. Lat. 12. 57. N.

BANGHIR, a town of Ireland, in King's county, in the province of Leinster, seated on the river Shannon. Long. 8. 5. W. Lat. 53. 10. N.

BANGOR, a city, the see of a bishop, in the county of Carnarvon, in North Wales, 253 miles from London, on the magnificent new road to Ireland by Holyhead. A harbour has recently been constructed, at which are loaded numerous vessels with slates, from the extensive quarries in that neighbourhood. The cathedral is very ancient, but neither large nor elegant: it is also used as a parish church. The diocese of Bangor comprehends the whole of Carnarvonshire except three parishes, all Anglesea, and a part of Denbigh, Merioneth, and Montgomery, containing in all 107 parishes. The inhabitants in 1801 amounted to 1790, in 1811 to 2393, and in 1821 to 3579.

BANGOR, a town of Ireland, in the county of Down, situated on the south shore of Carrickfergus Bay. Here is a small harbour, and a considerable fishery is carried on for soles, plaice, and turbot, and during the winter for cod and oysters. It is 114 miles N. by E. of Dublin.

BANGUEY, an island in the Eastern Seas, lying off the north coast of Borneo, and separated by a channel three miles wide, from the island of Balambangan. It is about 23 miles in length by 11 in breadth. Long. 117. 25. E. Lat. 7. 15. N.

BANIAK, an island in the Eastern Seas, off the west coast of Sumatra. It is one of a cluster of islands, and is about 17 miles in length by 7 in average breadth. Sea-slug or *biche de mer* is obtained here. Long. 96. 48. E. Lat. 2. 10. N.

BANIALUCH, or BAGNALUCH, a city of European Turkey, the capital of Bosnia, upon the frontiers of Dalmatia, near the river Setina. Long. 18. 20. E. Lat. 44. 20. N.

BANIANS, a religious sect in the empire of the Mogul, who believe in metempsychosis, and therefore refrain from eating any living creature, or killing even noxious animals, but endeavour to release them when in the hands of others. The name of Banian is used with some diversity, which has occasioned much confusion, and given rise to many mistakes. Sometimes it is taken in a less proper sense, and extended to all the idolaters of India, as contradistinguished from the Mahomedans; in which sense Banians includes the Brahmins and other castes. But Banians, in a more proper sense, is restricted to a peculiar caste or tribe of Indians, whose office or profession is trade and merchandise; in which sense Banians stand contradistinguished from Brahmins, Cuttery, and Wyse, the three other castes into which the Indians are divided. The four castes are absolutely separate as to occupation, relation, marriage, and condition, though all of the same religion, which is more properly denominated the religion of the Brahmins, who constitute the ecclesiastical tribe, than of the Banians, who form the mercantile. The proper Banians are called, in the Shaster, or book of their law, by the name of Shuddery; under which term are comprehended all who live after the manner of merchants, or deal and transact for others, as brokers, exclusively of the mechanics or artificers, who make another caste, called Wyse. These Banians have no peculiar sect or religion, unless it be that two of the eight general precepts given by their legislator Brahma to the Indian nation are, on account of the profession of the Banians, supposed more immediately to relate to them; namely, those which enjoin veracity in their word and dealings, and abstinence from circumvention in buying and selling. The Banians sometimes quit their business, and, retiring from the world, make a regular profes-

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sion of religion, as some a peculiar habit, and devote themselves more immediately to God, under the denomination of Vertea; and these, although they do not thereby change their caste, are commonly reckoned Brahmins of a more devout kind; just as monks in the Romish church, although frequently not in orders, are reputed a more sacred order than even the regular clergy. Indeed the name Banian imports as much in the sacred language of India, the depository of their written law; in which it means a people innocent and harmless, void of all guile, so gentle that they cannot endure to see either a fly or a worm injured, and who, when struck, will patiently bear it, without resisting or returning the blow. Their mien and appearance are thus described by a modern author: "A people presented themselves to my eyes clothed in linen garments, somewhat low descending; of a gesture and garb, as I may say, maidenly, and well nigh effeminate; of a countenance shy and somewhat estranged." Gemelli Carreri divides the Banians into twenty-two tribes, all distinct, and not allowed to intermarry. The author above quoted affirms that they are divided into eighty-two castes or tribes, corresponding to the castes or divisions of the Brahmins or priests, under whose discipline they are in religious matters; although the generality of the Banians choose to be under the direction of the two Brahminical tribes, the Visalnagranaugers and Vulnagranaugers.

The Banians are the great factors, by whom most of the trade of India is managed; in which respect they are comparable to the Jews and Armenians, and not behind either, in point of skill and experience, in whatever relates to commerce. Nothing is bought but by their mediation. They seem to claim a kind of *jus divinum*, grounded on their sacred books, to the management of the traffic, just as the Brahmins do to that of religion; and for this purpose they are dispersed throughout all parts of Asia, and abound in Persia, particularly at Ispahan and Gombroon, where many of them are extremely rich, yet not above acting as brokers where a penny is to be got by doing so. They act also as bankers, and can give bills of exchange for most cities in the East Indies. Their form of contract in buying and selling is remarkable, being done without words, in the profoundest silence, and only by touching each other's fingers. The buyer, loosing his pamerin or girdle, spreads it on his knee, and both he and the seller having their hands underneath, by the intercourse of the fingers mark in pounds, shillings, or pence, the price demanded, offered, and at length agreed on. When the seller takes the buyer's whole hand it denotes a thousand; and as many times as he squeezes it, as many thousand pagodas or rupees, according to the species in question, are demanded. When he takes the five fingers, it denotes five hundred; and when only one, one hundred; half a finger, to the second joint, denotes fifty, and the small end of the finger, to the first joint, stands for ten.

BANIER, ANTHONY, member of the Academy of Inscriptions and Belles-lettres, an ecclesiastic of the diocese of Clermont in Auvergne, was born in 1673. He is principally celebrated for his translation of the *Metamorphoses* of Ovid, with historical remarks and explanations; which was published in 1732, at Amsterdam, in folio, finely ornamented with copperplates by Picart, and reprinted at Paris in 1738, in two vols. 4to; and for his *Mythology or Fables of the Ancients, explained by History*; a work full of information, which was translated into English, and printed at London in 1741, in four vols. 8vo. He died at Paris in November 1741.

BANISTER, JOHN, a physician and surgeon in the reign of Queen Elizabeth, was educated at Oxford. In 1573 he took the degree of bachelor of physic; and, obtaining a licence from the university to practise, settled at

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Nottingham, where he lived many years in great repute, and wrote several medical and surgical treatises. The time of his death is not known. His works were collected and published in a 4to volume in 1633.

BANJARMASSIN, a town and district of Borneo, on the south-eastern coast, situated on a river of the same name, which has a shallow bar at the entrance. Many Chinese reside in this place, and carry on a considerable trade with China, exporting pepper, camphor, gold dust, wax, rattans, edible birds' nests, biche-de-mer, and spices, and importing opium, piece goods, coarse cutlery, gunpowder, and fire-arms. The Dutch for a long time maintained a factory here for the collection of pepper and rough diamonds. In 1700 the English also established a factory here; but the place was found to be extremely unhealthy, and the company's servants were finally attacked by the natives, whom they repulsed with great difficulty. The settlement was afterwards abandoned.

BANK, in *Political Economy*, an establishment for keeping money secure, and for dealing in money by discounting bills and otherwise. The history of banks will be given under the article **MONEY**. That class of banks whose object is to encourage habits of saving among labourers, called banks for savings, will be treated under the head of **SAVINGS BANKS**.

BANKER, a person who traffics and negotiates in money. The ancient bankers were called *argentarii* and *nummularii*; by the Greeks *τραπεζιται*, *κολλυβισται*, and *αργυρομοιροι*. Their chief business was to put out the money of private persons to interest. They had their boards and benches for this purpose in all the markets and public places, where they took in the money from some in order to lend it to others.

BANKING, or the science of a banker or dealer in money. This important subject will be treated under **MONEY**.

BANKING also denotes that branch of civil engineering which relates to the formation of banks to oppose the force of rivers, the sea, &c. See **EMBANKMENT**.

BANKRUPT, a person publicly declared to be in debt beyond his power of payment. Bankruptcy is distinguishable from insolvency. An insolvent is one who owes more than he can pay; he becomes a bankrupt when that inability is proclaimed by some public or judicial proceeding.

In England one is made bankrupt only by the issuing of a commission under the great seal, which deprives him of all his funds, and vests them in certain commissioners, to be assigned, managed, sold, and divided among his creditors.

In Scotland a person may be made bankrupt either, 1st, by a judicial process called sequestration, analogous to the English commission, by which his estate and effects are taken from him and vested in a trustee, to be managed and divided among his creditors; or, 2dly, by imprisonment for debt, or by absconding, taking sanctuary, or defending himself against the officers sent to arrest him.

The law for regulating bankruptcy has had in view chiefly persons engaged in trade: and the object in both countries has been to preserve the funds of a debtor on the eve of failure from being secreted, or placed in the hands of confidants, or given to favourite relations; to prevent the bankrupt from dealing unequally with his creditors on the eve of his failure; to place his estates and funds under economical management, in order that they may be realised, and the price divided among his creditors; to ascertain the true amount of his debts; to have a fair distribution made at certain terms; and to provide for the safety of the debtor's person, where he has dealt justly with his creditors, and given up every thing fairly for their payment. There is also ingrafted upon this pro-

ceeding, in either country, a mode of stopping short, after Bankrupt. due inquiry into the amount of the debts and value of the funds, and enabling a certain large majority of the creditors to make an agreement, which shall bind the whole, whereby the proceedings are superseded, immediate payment of part of the debts accepted as a composition for the whole, and the rest of the debt discharged. This is called a composition contract.

Provisions have also been made in both countries for regulating the interests of creditors, and the evil of imprisonment for debt, where the insolvent debtor is not engaged in trade. A short account of the laws established in both countries for regulating both those states of insolvency may be useful.

I. *Law of Bankruptcy and Insolvency in England.*—

1. *Commission of bankruptcy against persons engaged in trade.*—The law relating to the bankruptcy of persons engaged in trade is consolidated in one statute, 6 Geo. IV. c. 16. Where a trader or manufacturer either commits certain acts with the intent of defeating or delaying his creditors; or, having been arrested, lies for twenty days in prison; or declares himself insolvent, and gives notice thereof in the Gazette; a commission may, on the petition of a creditor making oath of debt to the amount at least of L.100, be issued by the Lord Chancellor under the great seal, appointing certain persons called commissioners of bankrupts to take order and direction with the body of the bankrupt, and his lands, estates, and funds of all kinds, and to make sale thereof for payment and satisfaction to the creditors. Notice is immediately published in the Gazette, and certain days are named, on which the bankrupt is to appear before the commissioners, and be examined in presence of his creditors; and the creditors are to appear and prove their debts, the commissioners having large inquisitorial powers for discovery of the bankrupt's funds. After the creditors have proved their debts, they are empowered to choose trustees, to whom the estate shall be assigned by the commissioners, in order to be sold and converted into money for division; and among the estates and funds so to be assigned are comprehended, 1st, all goods and chattels in the possession, order, disposition, and reputed ownership, of the bankrupt; 2d, all lands, debts, goods, &c. which, after insolvency, and without adequate consideration, the bankrupt shall have conveyed or transferred to his children or others; 3d, all property and effects transferred or affected by contracts or other dealings, or by executions or attachments subsequent to an act of bankruptcy, provided the party concerned have had notice of such act of bankruptcy, or that it shall have taken place within two calendar months of the commission. The assignees are ordered to make dividends among the creditors at certain periods, as the funds shall be realized, notice being given in the Gazette; and the bankrupt may be discharged from all his debts on procuring a certificate signed by a certain proportion of his creditors in number and value, and having it sanctioned by the Lord Chancellor, on hearing any objections which may be stated against the discharge. But no bankrupt can thus be discharged who has lost money at play, or by stockjobbing, to a certain amount; or who has destroyed his books, or made false entries, or concealed his property, or been privy to the proving of fictitious debts on his estate. Finally, the whole proceeding under the commission may be superseded by the Lord Chancellor, if, after the bankrupt shall have passed his last examination, proof shall be given to him of an offer of composition made by the bankrupt or his friends, and acceded to by nine tenths of the creditors in number and value.

2. *Insolvency.*—Provision has at various times been

Bankrupt. made in England, by occasional or temporary acts, for relieving insolvent persons not within the bankrupt laws, imprisoned for debt. But in 1820 a new court was established for the purpose of affording permanently the means of such relief, 1 Geo. IV. c. 119, and 5 Geo. IV. c. 61. The court consists of a chief and three commissioners, to sit in London, called *the Court for relief of Insolvent Debtors*. Any person in custody for debt within the walls of a prison in England is entitled to apply to this court, by summary petition, for his discharge from prison, and to have future liberty of his person from all debts due by him at the date of the petition, upon delivering a correct schedule of all his debts, and of all property and assets of every kind, and assigning every thing (except wearing apparel, bedding, &c. to the value of L.20), to the officer of the court, for the satisfaction of his creditors; to be by him made over to assignees appointed by the court, to sell and distribute the proceeds. Provision is made for due notice to the creditors, for the investigation of debts claimed, for the proper disposal of all the property, for the duly accounting of the assignees; and all conveyances and preferences given to creditors within three months are declared void. The prisoner's right to a discharge from prison is to be judged of by the court, on hearing the creditors and examining the prisoner; and the court is empowered to discharge him from prison if satisfied with his conduct, or to prolong his imprisonment in their discretion (not, however, exceeding three years), where he has concealed funds, destroyed books, &c. The court has power, where the debtor is not to be discharged, to order the creditor or creditors at whose suit he is detained, to pay to the prisoner a sum not exceeding four shillings by the week, on failure of which the prisoner is to be discharged. To avoid the expense of proceedings in London, the court may order the investigations to proceed in the court-house of the assize-town of the county; one of the commissioners of the court there attending, with all the powers of the court. And the court may appoint examiners to assist in the necessary investigations in counties. A prisoner found entitled to the benefit of the act is not liable to imprisonment for debts due previous to these proceedings, unless he shall succeed to or acquire property, and refuse to assign it to the assignees, for the benefit of his creditors; in which case the assignees may apply to have him remanded to prison; and provision is made for compelling the debtor to submit to examination as to property subsequently acquired.

II. *Law of Bankruptcy and Insolvency in Scotland.*—

1. *Bankruptcy of persons engaged in trade.*—By 54 Geo. III. c. 137, a judicial proceeding, called sequestration, is authorized to be issued by the Court of Session, on the petition of an insolvent trader or manufacturer in Scotland, with concurrence of a creditor swearing to a debt of L.100, or of a creditor to that amount without the concurrence of the debtor, provided the insolvency have been followed by imprisonment, absconding, or taking sanctuary, or by the execution of certain judicial warrants, if he be privileged from arrest. By this process the whole estates and effects of the debtor, real and personal, are placed under sequestration, to the effect of being made over to a trustee, as soon as the creditors can meet and choose a fit person; for which purpose a day is appointed, and notice given in the Gazette. The property is in the meanwhile managed by a factor, appointed by the creditors; and the trustee, when chosen, has the whole property assigned to him, and is entitled to recover, for the benefit of the creditors, all property and effects made over to confidential persons after insolvency, or conveyed to creditors in satisfaction or security of previous debts, within two months before sequestration or imprisonment. The

trustee's duty is to bring the whole estate to sale, with certain precautions; to receive and investigate the claims of the creditors, and to reject or admit them, subject to review of the Court of Session by summary petition. At certain appointed times he is required to make successive dividends, till the whole funds shall be exhausted. The debtor and his family must submit to public examinations on oath before the sheriff of the county in which his trade was carried on; and he may receive a judicial protection from arrest, if four fifths of his creditors in number and value shall think him entitled to it, and the trustee shall certify his conduct to be unexceptionable. And on the same conditions he may, after a certain time, be discharged of all his debts by the court, after hearing any creditor in opposition. The whole may also be superseded by composition, if (after the examinations as to the funds, and the lapse of sufficient time for the creditors to appear) a proposal of composition shall be made by the bankrupt, and assented to by nine tenths of the creditors in number and value: the court may judicially sanction it by discharging the bankrupt of all his debts on payment of the composition.

2. *Bankruptcy of persons not engaged in trade.*—By a statute in the end of the seventeenth century (1696, c. 5) the Scottish parliament provided, that any person insolvent and imprisoned upon caption, or taking sanctuary, or absconding, or defending himself by force against arrest, shall be deemed a bankrupt; and the effect of this is, 1st, that no preference given to one creditor over others within two months previous to the bankruptcy shall be effectual; 2d, that all attachments of goods, debts, &c. within the same term shall be unavailing to give preference to the creditor using them; 3d, that the debtor may apply to the Court of Session to be discharged from prison, after a month's imprisonment, on making a complete *cessio bonorum*, or surrender to his creditors of all his estates and effects; the court having power to judge of his right to such discharge, and to prolong his imprisonment (or rather to refuse his discharge), according to his conduct. His future acquisitions are liable to be attached by his creditors.

BANKS, JOHN, a dramatic writer, was bred to the law, and belonged to the society of Gray's Inn; but this profession not suiting his natural disposition, he quitted it for the service of the muses. His turn led him entirely to tragedy, in which his merit is of a peculiar kind; for at the same time that his language must be confessed to be extremely unpoetical, his numbers uncouth and unharmonious, his characters very far from being strongly marked or distinguished, and his episodes extremely irregular, yet it is impossible to avoid being deeply affected by the representation, and even by the reading, of his tragic pieces. These are, 1. *Albion Queens*. 2. *Cyrus the Great*. 3. *Destruction of Troy*. 4. *Innocent Usurper*. 5. *Island Queens*, which is only the *Albion Queens* altered. 6. *Rival Kings*. 7. *Virtue Betrayed*. 8. *Unhappy Favourite*. The *Albion Queens* was rejected by the managers in 1684, but was acted by Queen Anne's command in 1706. Neither the time of the birth nor that of the death of this author is ascertained. His remains, however, lie interred in the church of St James's, Westminster.

BANKS, *Sir Joseph*, for upwards of forty years the distinguished president of the Royal Society of London, was born in Argyle Street, London, on the 13th of February 1743. He was the only son of Mr William Banks, a gentleman of considerable landed property, whose father had derived his fortune principally from successful practice as a physician in Lincolnshire, who had, on one occasion, been sheriff of that county, and had for some years represented Peterborough in parliament. The family was

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Banks, originally Swedish, though it had for several generations been settled in England.

Very few particulars are known respecting the early life of Mr Banks, which was passed principally at Revesby hall, the seat of his father, in Lincolnshire. His education was for some years intrusted to a private tutor. He was afterwards sent to Harrow school, and thence was removed to Christ's College, Oxford. He there made considerable proficiency in classical knowledge, but evinced at the same time a very decided predilection for the pursuits of natural history. Botany, in particular, was the favourite occupation of his leisure hours. The character of Linnæus excited his admiration; and the fame of that illustrious naturalist presenting itself to his youthful mind as the noblest object of emulation, he devoted himself with enthusiastic ardour and perseverance to the cultivation of that fascinating science. An anecdote is told of his being, on one occasion, so intent in exploring ditches and secluded spots in search of rare plants, as to have excited the suspicions of some countrymen, who, conceiving that he could have no innocent design, surprised him one day, while he lay asleep, exhausted with fatigue, and brought him as a thief before a magistrate, by whom, however, he was, after a strict investigation, soon liberated; but the incident occasioned much amusement in the neighbourhood.

At the age of eighteen he lost his father, and thus succeeded to an ample inheritance at a period of life when the attractions of pleasure too often operate with irresistible force. His attachments to science and to intellectual enjoyments were fortunately sufficiently powerful to enable him to resist the fascination; and the noble bent of his ambition was happily fostered by the judicious conduct of his mother, who added the effectual motive of her encouragement, and gave the best direction to his youthful energy.

Soon after the death of her husband, Mrs Banks removed with her family, consisting of her son and daughter, from Lincolnshire, and was induced to fix her residence at Chelsea, as a spot affording peculiar advantages for the pursuit of botany, in consequence of the numerous gardens in the vicinity, appropriated to the cultivation of curious plants of every description. The garden of Sir Hans Sloane, bequeathed by him to the company of apothecaries of London, was among the number; and this, as well as the Chelsea Botanic Garden, and various nursery grounds in the neighbourhood, furnished our student with abundance of objects of research.

It was about this period that he formed an acquaintance with Lord Sandwich, contracted while enjoying together the amusement of fishing, of which they were both equally fond. To the friendship of this nobleman, afterwards appointed first lord of the admiralty, Mr Banks was, in the course of his life, indebted for essential aid in the furtherance of his numerous projects for the advancement of scientific knowledge. Mr Banks was no sooner of age than he quitted the university, and undertook a voyage to Newfoundland and the Labrador coast, for the purpose of exploring the botany of those unfrequented regions, and brought home from thence valuable collections, not merely of plants, but also of insects and other natural productions. Subsequently, through the interest of Lord Sandwich, then at the head of the admiralty, he obtained from government an appointment in the ship commanded by the great navigator Captain Cook, who had been commissioned to observe the transit of Venus in the Pacific Ocean, and to fulfil also the usual objects of a general voyage of discovery. The preparations made by Mr Banks for turning to the best account the opportunities that might present themselves during the voyage were commensu-

rate with the magnitude of the undertaking. He provided himself with the best instruments for making all kinds of observations, and for preserving specimens of natural history. He prevailed upon Dr Solander, a distinguished pupil of Linnæus, who had lately become resident in England, and was zealously devoted to the pursuits of science, to become his associate in this enterprise. He engaged draftsmen and painters to delineate all objects of interest that did not admit of being transported or preserved; and also other persons whose services might in various ways be wanted in the execution of his designs.

The time we are speaking of forms a remarkable epoch in the history of science, as being that in which several contemporaneous expeditions for the promotion of scientific knowledge were made by the direction of the leading sovereigns of Europe. The one intrusted to Captain Cook had for its object the alliance of navigation with astronomy, from which the nation has since reaped such important advantages. This was also the time when the empress Catharine of Russia ordered extensive expeditions in Siberia under the direction of the celebrated Pallas, the primary object of which was also the observation of the transit of Venus in that part of the world, but which gave occasion to the great advancement of natural history, and the acquisition of magnificent collections of specimens. It was also at this period that Bougainville was, by command of Louis XV., circumnavigating the globe, accompanied by Commerson, to whom science is indebted for such rich accessions of knowledge. But not the least among the valuable fruits of these researches has been the lesson they have imparted to mankind, how much more imperishable is the glory that redounds to princes and to nations from such conquests in the unexplored regions of science, than from the unprincipled extensions of empire or the barbarous triumphs of the sword.

The voyages of Captain Cook, and the interesting discoveries that accrued from them, have so long been justly esteemed an important accession to the fame of our country, that a portion of that reputation must be allowed to descend to all those whose exertions contributed to their success. Of this merit a considerable share must be adjudged to Mr Banks, who brought home a splendid collection of specimens, more particularly from Otaheite, New Zealand, and Australia.

This voyage occupied three years of the life of Banks; and no sooner was he returned from it than, with unabated ardour, we find him eager to undertake another of equal extent. He had engaged his passage in the second expedition under Captain Cook, and had made all the necessary preparations for embarking, when he was suddenly obliged to relinquish his design in consequence of the conduct of Sir Hugh Palliser, who, he discovered, had been using all his influence with the admiralty to thwart his views, and frustrate the accomplishment of all his objects. It is due to the memory of Cook to state, that he took no part in this intrigue, but expressed his uniform friendship for Banks, and his deep regret at being deprived of his able co-operation. Disappointed in his hopes, Mr Banks immediately directed his efforts to the equipment of a ship at his own expense; and taking with him Dr Solander, Dr Lind, De Troil, a Swedish naturalist, and others, who were to have been his companions in the second expedition with Captain Cook, he sailed for Iceland in July 1772; and after exploring, during two months, that interesting region of volcanoes, he returned enriched with valuable specimens and still more valuable information respecting its productions.

The island of Staffa, the existence of which was at that period scarcely known beyond the immediate neighbour-

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Sir Joseph.

hood, was visited by our travellers on their way to Iceland, and its extraordinary groups of basaltic columns attracted much of their attention. The account of these, together with the drawings taken on the spot, was liberally communicated by Mr Banks to Pennant, for publication among his works. The information relating to Iceland was given to the world by M. de Troil, who was afterwards appointed bishop of Linköping.

But a great part of the knowledge resulting from the various travels of Mr Banks was communicated by him, from time to time, in papers to the Royal Society of London, of which he had been elected a fellow in the year 1766, and admitted in the following year, previous to his voyage with Captain Cook. He was a constant attendant on the meetings of that society, and took a very active part in its proceedings. On the resignation of Sir John Pringle, in the year 1778, Mr Banks was elected president of the Royal Society, an honour which he continued to enjoy till his death. A fierce dispute having arisen respecting the superiority of pointed over blunt conductors for lightning, it would appear that Sir John Pringle had the ill fortune to differ in opinion from the men then in power at court, who, to flatter the prejudices of the sovereign, arrayed themselves in opposition to the discoveries of Franklin, which, emanating from America, were supposed to have necessarily a revolutionary character. It was in vain that the honest president of the Royal Society made an humble representation that the prerogatives of his office did not extend to the control of the laws of nature; superior influence compelled him to retire from a situation which he could not retain with honour amidst the angry passions called forth during these philosophical polemics. His successor was more fortunate, and enjoyed during his whole life the favour of the court; in proof of which the title of baronet was conferred upon him in the year 1781. In 1795 Sir Joseph Banks obtained also from his majesty the order of the bath; and in 1797 he was appointed a member of the privy council. It does not appear, however, that he mingled much in politics, though he occasionally gave his opinion, when consulted on such questions of public interest as involved subjects of science. But to the honour of Sir Joseph Banks it ought certainly to be recorded, that, whilst he was unremitting in his solicitude to retain the full influence he enjoyed with those in power, he never made that influence subservient to the purposes of a selfish ambition, and invariably exerted it for the promotion of scientific objects, and the encouragement of those who pursued them. He made the most generous use of his library and collections, which were always open to every inquirer of respectability. His ample fortune enabled him to supply pecuniary assistance to useful works and enterprises; and, what was often as effectually serviceable, he freely gave to those who sought it the benefit of his counsel and experience.

As proofs of the unreserved manner in which he communicated the scientific treasures he had amassed to those capable of making a proper use of them, many works on natural history may be mentioned which have been enriched by the information derived from these collections, and which even owe their existence to the encouragement thus afforded to their authors. It was by their aid that the celebrated Fabricius was enabled to prosecute his extensive entomological researches. Broussonnet availed himself largely of Sir Joseph Banks's specimens of fishes for his work on ichthyology. Botanists, in particular, derived the greatest assistance from the stores of his herbarium. From this source it was that Gærtner obtained the most valuable materials for his excellent history of fruits and seeds. The admirable work of Mr Robert Brown, *On the Plants of New Holland*, was conducted under the im-

mediate eye of Sir Joseph Banks, and with the aid of the materials derived from his collections.

Sir Joseph Banks evinced an anxiety to diffuse over each region of the globe the productions of other climates. Thus he brought into Europe the seeds of the plants of the South Sea Islands, as he had already distributed to the latter those of Europe. We are indebted to his exertions for many of the beautiful plants which adorn our gardens and shrubberies. The sugar-cane of Otaheite was by him transplanted into the colonies; and the bread-fruit tree of the Pacific was introduced into the tropical soil of America, destined perhaps to repay in a future age to its inhabitants the benefits we ourselves have derived from the potato they formerly furnished. The flax brought from New Zealand, superior in many of its qualities to that of Europe, is among the presents he has made us. The black swan and the kangaroo are among the animals from Australia, for the introduction of which into this country we are indebted to Sir Joseph Banks.

The establishment of the British colony in New South Wales was one of the results of the expedition of Captain Cook, to which the exertions of Sir Joseph Banks mainly contributed; and who will venture to predict the important consequences this event may have on the future destinies of that vast continent of which it forms a part?

At the commencement of the American war the French king, Louis XVI., had issued general orders to his officers in all parts of the world, to offer no molestation to the vessels engaged in the expedition of discovery under Captain Cook, but, on the contrary, to furnish them with every requisite assistance in the prosecution of their objects. Sir Joseph Banks, in the spirit of generous reciprocity, exerted himself successfully to obtain, that a perpetual immunity from the evils of war for those engaged in scientific enterprises should be recognised, as it now is, as one of the laws of civilized warfare. This virtuous principle, which forms an honourable exception to the demoralizing tendency of national animosities, was adhered to in the case of the expedition of La Pérouse, orders being sent by the British government, in time of war, to make every inquiry respecting the fate of that unfortunate navigator, and supply every aid that might be required, in case the survivors should be discovered. After the disastrous termination of the expedition under D'Entrecasteaux, the collection of Labillardière being captured and brought to England, Sir Joseph Banks exerted himself successfully to obtain its release and delivery, untouched, to the French government. His motive for abstaining from the inspection of its contents was, as he expressed in a letter to Jussieu, lest any part of that knowledge, to the acquisition of which so eminent a botanist had devoted the best years of his life, should become alienated from its rightful owner. On ten different occasions collections addressed to the National Museums of Paris, and captured by British privateers, were in like manner restored and forwarded to their proper destination.

Sir Joseph Banks continued to fill the exalted station of president of the Royal Society, the just reward of his ardent zeal and unwearied exertions in the cause of science, for a period of more than forty years; enjoying the correspondence and confidence of most of the distinguished men of learning of this and other nations. His name was enrolled amongst the associates of almost every academy and learned society in Europe. His house and his table were ever open for the reception and entertainment of the leading members of the Royal Society, and of foreigners eminent for their scientific attainments, with that spirit of liberality which is so conducive to the union of interests and co-operation of efforts requisite for the successful cultivation of knowledge. The want of such a

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Sir Joseph.

Banks's
Island
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Banner.

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centre of union has often led to the destruction of that harmony which should ever characterize men engaged in a common pursuit, calculated to raise them above vulgar passions; and the want of such harmony has always proved highly detrimental to the interests of science.

Notwithstanding the liberality that marked the conduct of Sir Joseph Banks in his intercourse with men of science of all countries, he had many bitter enemies; and his memory, soon after his death, was assailed by virulent invective. Yet his name will ever be remembered with gratitude by the friends of science, whom he benefited while living, and for whose use he bequeathed to the British Museum his books and botanical collections, under the care of that most distinguished botanist Mr Robert Brown. It is, however, not a little singular that, among the whole of his bequests, there is not one in favour of that society over which he had presided for above forty years, and from his connection with which he derived so much of the lustre which encompassed him; it would almost seem, indeed, as if he wished to be forgotten by them, since there is not a single syllable in his will expressive of his own recollection of that society.

Sir Joseph Banks was married, but had no family. During many of the latter years of his life he was a great sufferer from the gout, which almost totally deprived him of the use of his feet and legs. He died on the 19th of March 1820, having attained the age of 77. He was succeeded in the chair of the Royal Society for the remainder of the year by Dr Wollaston, and, at the ensuing anniversary, by Sir Humphry Davy, names that will ever remain illustrious in the annals of science. The only authentic particulars that have been yet published respecting the life of Sir Joseph Banks are contained in the *Eloge Historique* by the Baron Cuvier, which was read to the Royal Academy of Sciences at Paris on the 2d of April 1821, and published in the fifth volume of the Memoirs of that academy. (x.)

BANKS'S ISLAND, an island of New Zealand, of a circular form, about 60 miles in circumference, and visible at the distance of twelve or fifteen leagues. It is of a broken, irregular surface, and presents a barren appearance, though it is inhabited. It is fifteen miles from Tavai-Poenammoo. The south point lies in long. 186. 30. W. lat. 43. 32. S.

BANN, or **BAN** (from the Brit. *ban*, i. e. clamour), is a proclamation or public notice, any public summons or edict, in short, whereby a thing is commanded or forbidden. The word *banns* is used in England and in Scotland in publishing matrimonial contracts; which is done in the church before marriage, to the end that if any persons can speak against the intention of the parties, either in respect of kindred, precontract, or other just cause, they may take their exception before the marriage be consummated. The use of matrimonial banns is said to have been first introduced into the Gallican church, though something like it obtained even in the primitive times; and it is this that Tertullian is supposed to mean by *trimumdina promulgatio*. The council of Lateran first extended the usage and made it general.

BANN is also used to denote proscription or banishment for a crime proved, because anciently published by sound of trumpet; or, as Vossius thinks, because those who did not appear at the above-mentioned summons were punished by proscription. Hence "to put a prince under the bann of the empire," was to declare him divested of all his dignities.

BANN is further used as a solemn anathema, or excommunication attended with curses. In this sense we read of *papal banns*, &c.

BANNER denotes either a square flag, or the princi-

pal standard belonging to a prince. We find a multiplicity of opinions concerning the etymology of the word *banner*; some deriving it from the Latin *bandum*, a band or flag; others from the word *bann*, to summon the vassals to appear in arms; others again from the German *ban*, a field or tenement, because landed men alone were allowed a banner; and, finally, there are persons who think it a corruption of *pannière*, from *pannus*, cloth, because banners were originally made of cloth.

BANNERETS, an ancient order of knights, or feudal lords, who led their vassals to battle under their own flag or banner, when summoned by the king. The word seems formed from *banner*, a square flag, or from *band*, which anciently denoted a flag. Bannerets are also called by ancient writers *milites vexilliferi*, and *vexillarii bannerarii*, *bannarii*, *banderisii*, &c.

Anciently there were two kinds of knights, *great* and *little*; the first, called *bannerets*, composed of the upper, and the second, called *bachelors*, of the middle nobility. The banneret was allowed to march under his own flag, whereas the *bachelarius eques* followed that of another.

Banneret, according to Spelman, was a middle order between a baron and a simple knight. Hence he was sometimes called *vexillarius minor*, to distinguish him from the greater, that is, from the baron, to whom alone properly belonged *jus vexilli*, or privilege of the square flag. Hence the banneret was also called *bannerettus*, *quasi baro minor*; a word frequently used by English writers in the same sense as banneret was by the French, though neither of them occur before the time of Edward II.

Some are of opinion that bannerets were originally persons who had a portion of a barony assigned them, and enjoyed it under the title of *baro proximus*, with the same prerogatives as the baron himself. Others, again, find the origin of bannerets in France, in Brittany, or in England; attributing the institution to Conan, lieutenant of Maximus, who commanded the Roman legions in England under the sway of Gratian in A. D. 383. According to them, this general having revolted, divided England into forty cantons, and among these cantons distributed forty knights, to whom he gave power of assembling, on occasion, under their several banners, as many effective men as were to be found in their respective districts; whence they are called *bannerets*. But however this be, it appears from Froissart and others that, anciently, such of the military men as were rich enough to raise and subsist a company of armed men, and had a right to do so, were called *bannerets*: not, however, that these qualifications rendered them knights; they were only bannerets, and the appellation of knight was added thereto because they were simple knights before.

Bannerets were second to none but knights of the garter. They were reputed the next degree below the nobility, and were allowed to bear arms with supporters, which is competent to none else under the degree of a baron. In France, it is said, the dignity was hereditary; but in England it died with the person who gained it. On the institution of baronets by King James I. the order dwindled, and at length became extinct. The last person created banneret was Sir John Smith, who received the dignity after Edgehill fight, for his gallantry in rescuing the standard of King Charles I.

BANNOCKBURN, a village of Scotland, in the county of Stirling, and noted for the ever memorable battle fought near it on the 24th June 1314, between the Scottish and English armies, in which the latter was totally defeated.

BANQUETING ROOM or **HOUSE**. The ancient Romans supped in the *atrium*, or vestibule, of their houses; but in after-times magnificent saloons or banqueting-rooms were built, for the more commodious and splendid

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Bantry
Bay.

entertainment of their guests. Lucullus had several of these, each distinguished by the name of some god; and there was a particular rate of expense appropriated to each. Plutarch relates with what magnificence he entertained Cicero and Pompey, who went with a design to surprise him, by only telling a slave who waited, that the cloth should be laid in the Apollo. The emperor Claudius, among others, had a splendid banqueting-room named Mercury. But every thing of this kind was outdone by the lustre of the celebrated banqueting-house of Nero, called *domus aurea*, which, by the circular motion of its partitions and ceilings, imitated the revolution of the heavens, representing the different seasons of the year, which changed at every service, and showered down flowers, essences, and perfumes, on the guests.

BANSKA, a city in the circle of Hither Danube, in Hungary. It is the seat of a bishop, and of the civil and military rulers of the Comitatus of the Gran. There is a Catholic and a Lutheran ecclesiastical seminary established here. The inhabitants amount to 10,619, and are employed in making various metallic goods, and in the fabrication of arms. Long. 19. 3. 40. E. Lat. 48. 45. N.

BANTAM, a town of Java, capital of a district of the same name, at the north-western extremity of the island, situated on the Bay of Bantam, near the mouth of a river which falls into the bay. It was once a large, rich, and flourishing city, but now exhibits nothing except ruins, the memorials of its departed greatness. It is about 61 miles west from Batavia, and is situated on a low, swampy beach, surrounded by jungle, and intersected with stagnant streams, so that its climate is even more unhealthy than that of Batavia. The king formerly resided in a kind of palace built in the European style, within an old ruinous fort, containing 80 pieces of cannon; and contiguous to it was the Dutch fort. All these fortifications, both European and native, the Dutch fort as well as the sultan's fort, are levelled with the ground; and the few European habitations which have not been pulled down are falling fast into decay, and totally deserted. The court of the sultan, who resided here, had dwindled into insignificance, and the high-sounding title was merely retained. After Batavia surrendered to the British arms in 1812, this kingdom was in a state of great distraction; wherefore the British government of Batavia interfered in favour of the rightful heir, and restored him to the throne. Since that period the sultan, from apathy, and labouring under disease, has wholly resigned the government of Bantam, and voluntarily retired on a pension assigned him by the British, who took into their own hands the management of the country. In former times Bantam was a free port, open to the commerce of all nations. In 1683 the trade was monopolized by the Dutch, who erected Fort Spielwyk, to shut out all other merchants. This odious policy excited great discontents among the people, who were always the bitter enemies of the Dutch; but they were unable to shake off the yoke of their oppressors, who, about the year 1742, had succeeded in completely establishing their authority. The Bay of Bantam was formerly a commodious retreat for vessels; but it is now so choked up with daily accessions of new earth washed down from the mountains, as well as by coral shoals extending a considerable way to the eastward, that it is inaccessible to vessels of any considerable burden. Prior to the Dutch conquest, Bantam was a powerful state, the sovereign of which extended his conquests in the neighbouring islands of Borneo and Sumatra. The trade in pepper is the most considerable carried on here. Long. of the town of Bantam, 106. 3. E. Lat. 6. 4. S.

BANTRY BAY, a bay on the north-west coast of Ireland, in the county of Cork, about twenty-five miles

long by six or eight broad, with between ten and fourteen fathoms of water, surrounded by high mountains, and indented by creeks and inlets. It affords a very fine harbour for shipping, and contains two small islands, Bear and Whiddy. In 1796 a French fleet anchored here with a view of invading Ireland, and landed in a boat eight men, who were immediately taken prisoners. The fleet soon after left the coast. Long. 9. 24. to 9. 45. E. Lat. 51. 30. to 51. 40. N.

BAPTISM, in matters of religion, the ceremony or sacrament by which a person is initiated into the Christian church. The word is derived from the Greek βαπτίζω, a frequentative form of βαπτω, to dip or wash. Baptism is known in ecclesiastical writers by divers other names and titles. Sometimes it is called *palingenesis*, or *regeneration*; sometimes *salus*, or *life and salvation*; sometimes σφραγίς, *signaculum Domini*, and *signaculum fidei*, or *the seal of faith*; sometimes absolutely *mysterium*, and *sacramentum*; sometimes *the sacrament of faith*; sometimes *viaticum*, from its being administered to departing persons; sometimes *sacerdotium laici*, or the *lay priesthood*, because allowed, in cases of necessity, to be conferred by laymen; sometimes it is called the *great circumcision*, because it was imagined to succeed in the room of circumcision, and to be a seal of the Christian covenant, as circumcision was the seal of the covenant made with Abraham. In respect that baptism had Christ for its author, and not man, it was anciently known by the name of δῶρον and χάρισμα Κυρίου, *the gift of the Lord*; sometimes it was simply called δῶρον, without any other addition, by way of eminence, because it was both a gratuitous and singular gift of Christ. In reference to the making men complete members of Christ's body, the church, it had the name of τελειώσις, and τελειή, the *consecration* and *consummation*, because it gave men the perfection of Christians, and a right to partake of το τελειον, which was *the Lord's Supper*. It had also the name of μυσίς, and μυσταγωγία, the *initiation*, because it was the admittance of men to all the sacred rites and mysteries of the Christian religion.

Baptism has been supposed by many learned authors to have had its origin in the Jewish church, in which, as they maintain, it was the practice long before Christ's time to baptize proselytes or converts to their faith, as part of the ceremony of admission; and this practice, according to some, obtains among them to this day, a person turning Jew being first circumcised, and, when healed, bathed or baptized in water, in presence of the rabbin, after which he is reputed a good Jew. Others, however, insist that the Jewish proselyte baptism is not by far so ancient; and that John the Baptist was the first administrator of baptism among the Jews. Of this opinion were Deylingius, J. G. Carpzovius, Boernerus, Wernsdorffius, Zeltnerus, Owen, Knatchbull, Jennings, Gill, and others.

Grotius is of opinion that the rite of baptism derives its origin from the time of the Deluge, immediately after which, he thinks, it was instituted in memory of the world having been purged by water. Some learned men think it was added to circumcision soon after the Samaritan schism, as a mark of distinction to the orthodox Jews. Spencer, who is fond of deriving the rites of the Jewish religion from the ceremonies of the Pagans, lays it down as a probable supposition, that the Jews received the baptism of proselytes from the neighbouring nations, who were wont to prepare candidates for the more sacred functions of their religion by a solemn ablution, that, by this affinity of sacred rites, they might draw the Gentiles to embrace their religion, and that the proselytes, in the gaining of whom they were extremely diligent, might the more easily comply with the transition from Gentilism to

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Baptism. Judaism. In confirmation of this opinion, he observes, first, that there is no divine precept for the baptism of proselytes, God having enjoined only the rite of circumcision for the admission of strangers into the Jewish religion; and, secondly, he contends, that, among foreign nations, the Egyptians, Persians, Greeks, Romans, and others, it was customary for those who were to be initiated into their mysteries or sacred rites, to be first purified by dipping the whole body in water. The same learned writer adds, as a further confirmation of his opinion, that the cup of blessing, added to the paschal supper, seems likewise to have been derived from a pagan original; as the Greeks at their feasts had one cup called *ποτηριον αγαθου δαιμονος*, *the cup of the good demon or god*, which they drank at the conclusion of their entertainment when the table was removed. Since, then, a rite of Gentile origin was added to one of the Jewish sacraments, namely, the passover, there can be no absurdity, he thinks, in supposing that baptism, which was added to the other sacrament, namely circumcision, might be derived from the same source. In the last place, he observes, that Christ, in the institution of his sacraments, paid a peculiar regard to those rites which were borrowed from the Gentiles; for, rejecting circumcision and the paschal supper, he adopted into his religion baptism and the sacred cup; thus preparing the way for the conversion and reception of the Gentiles into his church.

The design of the Jewish baptism, if baptism was practised by them, is supposed to have been to import a regeneration, whereby the proselyte was rendered a new man, and from being a slave became free. The effect of it was, to cancel all former relations; so that those who were before akin to the person, after the ceremony ceased to be so. It is to this ceremony Christ is supposed to have alluded, in his expression to Nicodemus, that it was necessary that he should be born again, in order to become his disciple. The necessity of baptism to salvation is grounded on these two sayings of our Saviour, "He that believeth, and is baptized, shall be saved;" and "Except a man be born of water and of the Spirit, he cannot enter into the kingdom of God." The ancients did not generally think the mere want of baptism, where the procuring of it was impracticable, excluded men absolutely from the hopes of eternal salvation. Some few of them, indeed, are pretty severe upon infants dying without baptism; and others seem also, in general terms, to deny eternal life to adult persons dying unbaptized. But when they interpret themselves, and speak more distinctly, they make some allowances, and specially except several cases in which the want of baptism may be supplied by other means. Such is martyrdom, which commonly goes by the name of "second baptism in men's own blood" in the writings of the ancients, because of the power and efficacy it was thought to have in saving men by the invisible baptism of the Spirit, without the external element of water. Faith and repentance were also esteemed a supplement to the want of baptism, in such catechumens as died whilst they were piously preparing themselves for baptism. Constantly communicating with the church was also thought to supply the want of baptism to persons who had been admitted to communion on a presumption of their having been duly baptized, though the contrary afterwards appeared. For infants dying without baptism, the case was thought more dangerous; as here, no personal faith, repentance, or the like, could be pleaded, to supply the defect, and to wash away original sin. On this account, they who spoke most favourably of them, as Gregory Nazianzen, and Severus, bishop of Antioch, only assigned them a middle state, neither in heaven nor hell. But the Latins, as St Augustine, Fulgentius, Marius Mercator, and others, who never

admitted the opinion of a middle state, concluded, that, as they could not be received into heaven, they must go to hell. Pelagius and his followers, who denied original sin, asserted that they might be admitted to eternal life and salvation, although not to the kingdom of heaven; between which a distinction was made. Where the fault lay not on the side of the child, nor his parents, but on that of the minister, or where any unavoidable accident rendered baptism absolutely impossible, Hincmar and others made an exception, holding that the child might in that case be saved without baptism.

The receiving of baptism is not limited to any time, nor to any age of life. Some contend for its being administered like circumcision, precisely on the eighth day, as Gregory Nazianzen; while others would have it deferred till the child is three years of age, and able to hear the mystic words, and make answer thereto, though he do not understand them. In the canon law we find divers injunctions against deferring the baptism of infants beyond certain days, as the ninth, thirtieth, and thirty-seventh, some of them involving pecuniary forfeitures in case of disobedience.

Salmasius, and Suicerus after him, deliver it as authentic history, that for the first two ages no one received baptism who was not first instructed in the faith and doctrine of Christ, so as to be able to answer for himself that he believed; and this by reason of the words, "He that believeth and is baptized;" which in effect is to say, that no infant, for the first two ages, was ever admitted to Christian baptism. They own, however, that paedobaptism afterwards came in, upon the opinion that baptism was necessary to salvation. But Vossius, Dr Forbes, Dr Hammond, Mr Walker, and especially Mr Wall, who has exactly considered the testimony and authority of almost every ancient writer who has said any thing upon this subject, endeavour to evince that infants were baptized even in the apostolical age; and it is certain that Tertullian pleads strongly against giving baptism to infants; which at least shows that there was some such practice in his age, though he disapproved of it. But the ordinary subjects of this sacrament in the first ages were converts from Judaism and Gentilism, who, before they could be admitted to baptism, were obliged to spend some time in the state of catechumens, to qualify them for making their professions of faith and a Christian life, in their own persons; for, without such personal professions, there was ordinarily no admission of them to the privilege of baptism. Those baptized in their sick beds were called *clinici*, and held in some reproach, as not being reputed good Christians; and hence we meet with several censures of clinic baptism in councils and ecclesiastical writers. But this clinic baptism was not sufficient to qualify the person, in case of recovery, for ordination. Some had their baptism put off by way of punishment, when they fell into gross and scandalous crimes, which were only to be expiated by a long course of discipline and repentance. This sometimes included five, ten, twenty, or more years; in particular cases the whole of life to the very hour of death, when very flagrant crimes had been committed.

In the earliest ages of the church, there was no stated time or place for the reception of baptism. Afterwards, Easter, Whitsuntide, and Epiphany, became solemn seasons, out of which baptism was not administered, except in cases of necessity. The catechumens who were to receive it at these times were called *competentes*; and it is to these that St Cyril addresses his catecheses. In the apostolical age, and some time after, before churches and baptisteries were generally erected, they baptized in any place where they had convenience; for example, John baptized in Jordan, Philip baptized the eunuch in the

Baptism. wilderness, and Paul baptized the jailer in his own house. But in after-ages baptisteries were built adjoining to the churches; and then rules were made that baptism should ordinarily be administered nowhere except in these buildings. Justinian, in one of his novels, refers to ancient laws appointing that none of the sacred mysteries of the church should be celebrated in private houses. Men might have private oratories for prayer in their own houses; but they were not to administer baptism or the eucharist in them, unless by a particular license from the bishop of the place. Such baptisms are frequently condemned in the ancient councils, under the name *παράβαπτισματα*, baptisms in private conventicles.

As to the attendant ceremonies and manner of baptism in the ancient church, the person to be baptized, if an adult, was first examined by the bishop or officiating priest, who put some questions to him; as, first, whether he abjured the devil and all his works, and, secondly, whether he gave a firm assent to all the articles of the Christian faith; to each of which he answered in the affirmative. If the person to be baptized was an infant, these interrogatories were answered by his *sponsors* or godfathers. Whether the use of sponsors was as old as the days of the apostles is uncertain; the probability is it was not, since Justin Martyr, speaking of the method and form of baptism, says not a word of them. After the questions and answers, followed exorcism, the manner and end of which was this: The minister laid his hands on the person's head, and breathed in his face, implying thereby the driving away or expelling of the devil, and preparing the convert for baptism, by which the good and holy spirit was to be conferred upon him. After exorcism followed baptism itself. And, first of all, the minister, by prayer, consecrated the water for that purpose. Tertullian says, "any waters may be applied to that use; but then God must be first invoked; on which the Holy Ghost presently comes down from heaven, and moves upon them, and sanctifies them." The waters having been consecrated, the person was baptized "in the name of the Father, and of the Son, and of the Holy Ghost;" by which "dedication of him to the blessed Trinity, the person," says Clemens Alexandrinus, "is delivered from that corrupt trinity, the devil, the world, and the flesh." In performing the ceremony of baptism, the usual custom, except in clinical cases, or where there was scarcity of water, was to immerse the whole body. Thus St Barnabas, describing a baptized person, says, "We go down into the water full of sin and filth, but we ascend bearing fruit in our hearts." And this practice of immersing the whole body was so general, that we find no exception made from respect either to the tenderness of infants or the bashfulness of the other sex, unless in case of sickness or disability. But, to prevent any indecency, men and women were baptized apart; to which end, either the baptisteries were divided into two apartments, one for the men, the other for the women, as Bingham has observed; or the men were baptized at one time and the women at another, as is shown by Vossius, from the *Ordo Romanus*, Gregory's *Sacramentarium*, and other authorities. Add to this, that there was anciently an order of deaconesses, one part of whose business was to assist at the baptism of women. These precautions, however, rather indicate a scrupulous attention to delicacy, than imply any indecency in the circumstance of immersion itself. From the circumstance of candidates being immersed, however, there is no reason to infer that immersion was made in a state of nudity. The present Baptists never baptize naked, though they always immerse. After immersion followed the unction; by which, according to St Cyril, was signified that they were now cut off from the

wild olive, and were ingrafted into Christ, the true olive tree; or else to show that they were now to be champions for the gospel, and were anointed thereto, as the old athletes were for their solemn games. With this anointing was joined the sign of the cross, made upon the forehead of the person baptized; which being done, he had a white garment given him, to denote his being washed from the defilements of sin, or in allusion to that of the apostle, "As many as are baptized in Christ have put on Christ." From this custom the feast of Pentecost, which was one of the annual seasons of baptism, came to be called *Whitsunday* or *Whitsunday*. The garment in question was afterwards laid up in the church, that it might be an evidence against such persons as violated or denied that faith which they had owned in baptism. When the baptism was performed, the person baptized, according to Justin Martyr, "was received into the number of the faithful, who then sent up their public prayers to God for all men, for themselves, and for those who had been baptized."

The ordinary ministers, who had the right of administering this sacrament, that is, of applying the water to the body, and pronouncing the formula, were presbyters or bishops; but on extraordinary occasions laymen were admitted to perform the same.

The present form of administering baptism in the church of Rome is as follows:—When a child is to be baptized, the persons who bring it wait at the door of the church for the priest, who comes thither in his surplice and purple stole, attended by his clerks. He begins with questioning the godfathers, whether they promise, in the child's name, to live and die in the true Catholic and Apostolic faith, and what name they would give the child. Then follows an exhortation to the sponsors; after which the priest, calling the child by its name, asks, "What dost thou demand of the church?" The godfather answers, "Eternal life." The priest proceeds: "If you are desirous of obtaining eternal life, keep God's commandments, thou shalt love the Lord thy God," &c.; after which he breathes three times in the child's face, saying, "Come out of this child, thou evil spirit, and make room for the Holy Ghost." Then he makes the sign of the cross on the child's forehead and breast, saying, "Receive the sign of the cross on thy forehead and in thy heart;" upon which, taking off his cap, he repeats a short prayer, and laying his hand gently on the child's head, repeats a second prayer; then he blesses some salt, and, putting a little of it into the child's mouth, pronounces these words, "Receive the salt of wisdom." All this is performed at the church door. The priest, with the godfathers and godmothers, coming into the church, and advancing towards the font, repeat the apostles' creed and the Lord's prayer. Arrived at the font, the priest exorcises the evil spirit again; and taking a little of his own spittle, with the thumb of his right hand rubs it on the child's ears and nostrils, repeating, as he touches the right ear, the same word, *Ephatha, be thou opened*, which our Saviour made use of to the man born deaf and dumb. Lastly, they pull off its swaddling-clothes, or strip it below the shoulders, during which the priest prepares the oil. The sponsors then hold the child directly over the font, observing to turn it due east and west; whereupon the priest asks the child, "whether he renounces the devil and all his works;" and the godfather having answered in the affirmative, the priest anoints the child between the shoulders in the form of a cross; then taking some of the consecrated water, he pours part of it thrice on the child's head, at each perfusion calling on one of the persons of the Holy Trinity. The priest concludes the ceremony of baptism with an exhortation. It may be added, that the Romish church allows midwives, in cases of danger, to baptize a

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Baptism. child before it comes entirely out of its mother's womb; but it is to be observed, that as some part of the body of the child must appear before it can be baptized, it is baptized on that which first appears: if it be the head, it is not necessary to rebaptize the child; but if only a foot or hand appears, baptism must be repeated. A still-born child thus baptized may be buried in consecrated ground.

The Greek church differs from the Romish as to the rite of baptism, chiefly in performing it by immersion, or plunging the infant all over in the water.

The forms of administering baptism among us being too well known to require a particular description, we shall only mention one or two of the more material differences between the form as it stood in the first liturgy of King Edward, and that in the English Common Prayer Book at present. First, the form of consecrating the water did not make a part of the office in King Edward's liturgy, as it does in the present, because the water in the font was changed and consecrated but once a month. The form itself likewise was something different from that now used, and was introduced with a short prayer, that Jesus Christ, upon whom (when he was baptized) the Holy Ghost came down in the likeness of a dove, would send down the same Holy Spirit, to sanctify the fountain of baptism; which prayer was afterwards left out at the second review. By King Edward's first book the minister was required to dip the child in the water thrice; first, the right side; secondly, the left; and, lastly, the face toward the foot. This triple immersion was a very ancient practice in the Christian church, and used in honour of the Holy Trinity; though some later writers say that it was done to represent the death, burial, and resurrection of Christ, together with his three days' continuance in the grave. But afterwards, when the Arians made an improper use of it, persuading the people that it denoted a distinct substantiality of the three persons in the Trinity, the orthodox left it off and used only one single immersion.

By the first common prayer of King Edward, after the child was baptized, the godfathers and godmothers were to lay their hands upon it, and the minister was to put on him the white vestment, commonly called the *chrysom*, and to say, "Take this white vesture as a token of the innocency which, by God's grace, in this holy sacrament of baptism, is given unto thee, and for a sign whereby thou art admonished, so long as thou livest, to give thyself to innocence of living, that after this transitory life thou mayest be partaker of the life everlasting." As soon as he had pronounced these words he was to anoint the infant on the head, saying, "Almighty God, the father of our Lord Jesus Christ, who hath regenerated thee by water and the Holy Ghost, and hath given unto thee remission of all thy sins, may he vouchsafe to anoint thee with the unction of his Holy Spirit, and bring thee to the inheritance of everlasting life."

The custom of sprinkling children instead of dipping them in the font, which at first was allowed in case of the weakness or sickness of the infant, has so far prevailed that immersion is now quite excluded. What principally tended to confirm the practice of affusion or sprinkling was, that several of our Protestant divines flying into Germany and Switzerland during the bloody reign of Queen Mary, and returning home when Queen Elizabeth came to the crown, brought back with them a great zeal for the Protestant churches beyond sea where they had been sheltered and received; and having observed that at Geneva and other places baptism was administered by sprinkling, they thought they could not do the church of England a greater piece of service than by introducing a practice dictated by so great an authority as Calvin. This, together with the coldness of our northern climate, was

Baptism. what contributed to banish entirely the practice of immersing infants in the font.

The different notions which have been entertained concerning the effects of baptism, it would be endless to enumerate. The Remonstrants and Socinians reduce baptism to a mere sign of divine grace. The Romanists, on the contrary, exalt its power, holding, that thereby all sin is entirely taken away by it; that it absolutely confers justification, and consequently grace *ex opere operato*. Some also speak of an indelible character impressed on the soul by it, called *character dominicus*, and *character regius*; but others hold this a mere chimera, maintaining that the spiritual character conferred in regeneration may easily be effaced by mortal sins. Dodwell contends that it is by baptism that the soul is made immortal, and that those who die without it cannot rise again; but he limits this effect to episcopal baptism alone. From the effects ordinarily ascribed to baptism, even by ancient writers, it would seem that the ceremony is as much of heathen as Jewish origin, since Christians do not restrain the use of it, like the Jews, to the admission of new members into the church, but hold, with the heathens, that it contains a virtue for remitting and washing away sins. The Brahmins are still said to baptize with this latter view at certain seasons in the river Ganges, to the waters of which they ascribe a cleansing or sanctifying quality; and hence it is that people flock from all parts, even of Tartary, in expectation of being thus eased of their load of sins. But in this point many Christians seem to have gone beyond the folly of the heathens. It was only the smaller sins of infirmity which these latter held to be expiable by washing; for crimes of a blacker dye, they allowed, no water could efface, no purgation discharge them. The Christian doctrine of a total remission of sins by baptism could not fail, therefore, to scandalize many amongst the heathen, and furnished the apostate Julian with an occasion for ridiculing Christianity itself: "Whoever," says he, "is guilty of rapes, murders, sacrilege, or any abominable crime, let him be washed with water, and he will become pure and holy."

In the ancient church, baptism was frequently conferred on Jews by violence; but the church itself never seems to have allowed of force on this occasion. By a canon of the fourth council of Toledo, it is expressly forbidden to baptize any one against his or her will. That which looks most like force in this case is to be found in two orders of Justinian; one of which appoints the heathen, and the other the Samaritans, to be baptized, with their wives and children and servants, under pain of confiscation. By the ancient laws, baptism was not to be conferred on image-makers, stage-players, gladiators, *aurigæ* or public drivers, magicians, or even strolling beggars, until they quitted such professions. Slaves were not allowed the privilege of baptism without the testimony and consent of their masters; excepting the slaves of Jews, heathens, and heretics, who were not only admitted to baptism, but, in consequence of the rite, had their freedom conferred on them.

Baptism by Fire, spoken of by John the Baptist, has given rise to much conjecture. The generality of the fathers held that believers, before they enter paradise, must pass through a certain fire, which is to purify them from all pollutions remaining unexpiated. But some, with St Basil, understand it of the fire of hell; others, of that of tribulation and temptation; while a few, with St Chrysostom, will have it to denote an abundance of graces. Some suppose it to mean the descent of the Holy Ghost on the apostles, in the form of fiery tongues; others maintain, that the word *fire* here is an interpolation, and that we are only to read the text, "He that shall come after me will baptize you with the Holy Ghost."

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The ancient Selucians and Hermians, understanding the passage literally, maintained that material fire was necessary in the administration of baptism. But we do not find how or to what part of the body they applied it, or whether they were satisfied with obliging the person baptized to pass through the fire. Valentinus rebaptized all who had received water-baptism, and conferred on them the baptism of fire.¹ Heracleon, cited by Clemens Alexandrinus, says that some applied a red-hot iron to the ears of the person baptized, as if to impress some mark upon him.

Baptism of the Dead, a custom which anciently prevailed among some people in Africa, of giving baptism to the dead. The third council of Carthage speak of it as a thing which ignorant Christians were fond of. Gregory Nazianzen also takes notice of the same superstitious opinion prevailing among some who delayed to be baptized. In his address to this kind of men, he asks, whether they stayed to be baptized after death. Philastrius also notices it as the general error of the Montanists or Cataphrygians, that they baptized men after death. The practice seems to have been grounded on a vain opinion, that when men had neglected to receive baptism in their life-time, some compensation might be made for this default by receiving it after death.

Baptism of the dead was also a sort of vicarious baptism, formerly in use, when, in the case of a person dying without baptism, another was baptized in his stead. This, St Chrysostom tells us, was practised among the Marcionites with a great deal of ridiculous ceremony. When a catechumen happened to die, they hid a living man under the bed of the deceased: then coming to the dead man, they asked him whether he would receive baptism; and he making no reply, the other answered for him, and said he would be baptized in his stead; and so they baptized the living for the dead. Epiphanius assures us the like was also practised amongst the Corinthians. This practice they pretended to found on the Apostle's authority, alleging that text of St Paul for it, "If the dead rise not at all, what shall they do who are baptized for the dead?" a text which has given occasion to a great variety of different systems and explications. Vossius enumerates no less than nine different opinions among learned divines concerning the sense of the phrase, being "baptized for the dead."

Hypothetical Baptism was that formerly administered in certain doubtful cases, with the formula, "If thou art baptized, I do not rebaptize; if thou art not, I baptize thee in the name of the Father," &c. This sort of baptism, enjoined by some ancient constitutions of the English church, has now fallen into disuse.

Solemn Baptism was that conferred at stated seasons. Such, in the ancient church, were the paschal baptism, and that at Whitsuntide. This is sometimes also called general baptism.

Lay Baptism we find to have been permitted both by the common prayer-book of King Edward and by that of Queen Elizabeth, when an infant is in immediate danger of death, and a lawful minister cannot be had. This was founded upon the mistaken notion of the impossibility of salvation without the sacrament of baptism; but afterwards, when they came to have clearer notions of the sacraments, it was unanimously resolved, in a convocation held in the year 1575, that even private baptism, in a case of necessity, was only to be administered by a lawful minister.

BAPTISM is also applied abusively to certain ceremonies used in giving names to things inanimate. The an-

cients knew nothing of the custom of giving baptism to inanimate things, as bells, ships, and the like, by a superstitious consecration of them. The first notice we have of this is in the capitulars of Charles the Great, where it is mentioned with censure; but afterwards it crept by degrees into the Roman offices. Baronius carries its antiquity no higher than the year 968, when the great bell of the church of Lateran was christened by Pope John III. At last it grew to such superstitious height as to form a ground of complaint in the *Centum Gravamina* of the German nation, drawn up in the public diet of the empire held at Nuremberg in the year 1581; where, after describing the ceremony of baptizing a bell, with godfathers, who made responses as in baptism, and gave it a name, and clothed it with a new garment as Christians were used to be clothed withal, and all this to make it capable of driving away tempests and devils, they conclude against it as not only a superstitious practice, but contrary to the Christian religion, and a mere seduction of the simple people.

BAPTISMAL VOW or COVENANT, a profession of obedience to the laws of Christ, which persons in the ancient church made before baptism. It was an indispensable part of the obligation on catechumens before they were admitted to the ceremony of regeneration. The vow was made by turning to the east, for what mystical reason is not well agreed on.

BAPTISMAL Presents, in use in Germany, were made by the sponsors to the infant, and consisted of money, plate, or even sometimes fiefs of lands, which by the laws of the country were to be kept for the child until he became of age; the parents having only the trust, not the right of disposing of them.

BAPTIST, JOHN MONNOYER, a painter of flowers and fruit, was born at Lisle in 1635, and educated at Antwerp, where he perfected himself in the knowledge of his art, and in his first years was intended for a painter of history; but having soon found that his genius more strongly inclined him to the painting of flowers, he applied his talents to those subjects, and in that style became one of the greatest masters. His pictures are not so exquisitely finished as those of Van Huysum, but his composition and colouring are in a bolder style. He died in 1699, leaving a son, Anthony, who followed his father's profession, and had great merit.

BAPTISTS, in *Ecclesiastical History*, a denomination of Christians, distinguished from other Christians by their particular opinions respecting the mode and the subjects of baptism.

Instead of administering the ordinance by sprinkling, they maintain that it ought to be administered only by immersion. Such, they insist, is the import of the word βαπτίζω; so that a command to baptize is a command to immerse. And thus it was understood by those who first administered it. John the Baptist and the apostles of Christ administered it in Jordan and other rivers and places where there was much water. Both the administrators and the subjects are described as going down into and coming up again out of the water; and the baptized are said to be buried in baptism, and to be raised again; which language could not, they say, be properly adopted on supposition of the ordinance being administered in any other manner than by immersion. Thus also, they affirm, it was in general administered in the primitive church; thus it is now administered in the Russian and Greek church; and thus it is at this day directed to be administered in the church of England to all who are thought

Baptismal
Vow
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Baptists.

¹ Bis docuit tingi, transducto corpore flamma. (Tertull. *Carm. contr. Marc.* lib. i.)

Baptists. capable of submitting to it in this manner. With regard to the subjects of baptism, the Baptists say that this ordinance ought not to be administered to children or infants at all, nor to grown up persons in general; but to adults only of a certain character and description. Our Saviour's commission to his apostles, by which Christian baptism was instituted, is to go and teach all nations, baptizing them; that is, say they, not to baptize all they meet with, but first to instruct them, to teach all nations, or to preach the gospel to every creature, and whoever receives it, him to baptize in the name of the Father, and of the Son, and of the Holy Ghost. To such persons, and to such only, baptism appears to have been administered by the apostles and the immediate disciples of Christ. They are described as repenting of their sins, as believing in Christ, and as having gladly received the word. Peter acquaints those who were converted by his sermon, that without these qualifications he could not have admitted them to baptism; Philip holds the same language in his discourse with the Ethiopian eunuch; and Paul treats Lydia, the jailer, and others, in the same manner. Without these qualifications Christians in general think it wrong to admit persons to the Lord's supper; and for the same reasons, without these qualifications, or at least a profession of them, the Baptists think it wrong to admit any to baptism. Wherefore they withhold it, not only from the impenitently vicious and profane, and from infidels, who have no faith, but also from infants and children, who have no knowledge, and are incapable of every action civil and religious. They further insist that all positive institutions depend entirely upon the will and declaration of the founder; wherefore, that reasoning by analogy from abrogated Jewish rites is to be rejected, and the express commands of Christ respecting the mode and subjects of baptism ought to be our only rule.

The Baptists in England form one of the denominations of Protestant dissenters. They separate from the establishment for the same reasons as their brethren of the other denominations do; and an additional motive is derived from their particular tenets respecting baptism. The constitution of their churches, and their mode of worship, is congregational or independent; and in the exercise of it they are protected, in common with other dissenters, by the act of toleration. Before this act they were liable to pains and penalties as nonconformists, and often for their peculiar sentiments as Baptists. A proclamation was in fact issued out against them, and some of them were burnt in Smithfield in 1538. They bore a considerable share in the persecutions of the seventeenth and preceding centuries, and, as it should seem, in those of even an earlier date; for among the Lollards and the followers of Wickliffe there were several who disapproved of infant baptism, and there were many of this persuasion among the Protestants and reformers abroad. In Holland, Germany, and the North, they went by the names of Anabaptists and Mennonites; and, in Piedmont and the south, they were found among the Albigenses and Waldenses.

The *Baptists* subsist under two denominations; the Particular or Calvinistical, and the General or Arminian. The former is by far the most numerous. Some of both denominations allow of *mixed communion*, that is, with persons who have been sprinkled in their infancy, and therefore unbaptized in the view of the Baptists. Others, again, disallow it; and a few of them observe the seventh day of the week as the Sabbath, apprehending the law that enjoined it not to have been repealed by Christ or his apostles. But a difference of opinion respecting these and other matters is not peculiar to the Baptists, being common to all Christians, and to all bodies of men who think and judge for themselves.

BAPTISTERY, in ecclesiastical language, the name of Baptistry a place in which the ceremony of baptism is performed.

In the ancient church it was one of the exhedræ or buildings distinct from the church itself, and consisted of a porch or anti-room where the persons to be baptized made their confession of faith, and an inner apartment where the ceremony of baptism was performed. Thus it continued till the sixth century, when the baptisteries began to be taken into the church-porch, and afterwards into the church itself. The ancient baptisteries were commonly called φωτιστήρια, *photisteria*, or places of illumination, because they were the places of instruction preceding baptism; and in these the catechumens seem to have been trained up, and instructed in the first rudiments of the Christian faith.

Those baptisteries were anciently very capacious, because the stated times of baptism returning but seldom, there were usually great multitudes to be baptized at the same time; and also because the manner of baptizing by immersion or dipping under water made it necessary to have a large font. In Venantius Fortunatus it is called *aula baptismatis*, the large hall of baptism; which was indeed so large, that we sometimes read of councils meeting and sitting therein. This hall, or chapel, was always kept shut during Lent, and the door sealed up with the bishop's seal, not to be opened till Maunday-Thursday. The baptistery was always reputed a sacred place. In the Roman order baptisteries were built of a round figure, and distinguished with the image of St John the Baptist, while over the basin or font was a figure of a dove in gold or silver, to represent the Holy Ghost.

The name *baptistery* is sometimes also given to a kind of chapel in a large church, which served for the same office. It is an observation of some learned men, that anciently there was but one baptistery in a city, namely, at the bishop's church; and that afterwards they were set up in parish churches, with the special allowance, however, of the bishop.

BAR, in courts of justice, denotes an inclosure made with a partition of timber, where the counsel are placed to plead causes, and where prisoners are brought to answer to indictments, &c. It corresponds to what among the Romans was denominated *tribunal*. The French call it *barre d'audience*. In England, lawyers who are called to the bar, or licensed to plead, are termed *barristers*, an appellation equivalent to *licentiate* in other countries.

BAR, in *Heraldry*, an ordinary in form of the fess, but much less. See **HERALDRY**.

BAR, in *Music*, a stroke drawn perpendicularly across the lines of a piece of music, including between each two a certain quantity or measure of time, which is various as the time of the music is either triple or common. In common time, between each two bars is included the measure of four crotchets; in triple, three. The principal use of bars is to regulate the beating of time in a concert. The use of bars is not to be traced higher than the time when the English translation of Adrian le Roy's book on the Tablature was published, namely, the year 1574; and it was not until some time after that the use of bars became general. Barnard's cathedral music, printed in 1641, is without bars; but bars are to be found throughout in the *Ayres and Dialogues* of Henry Lawes, published in 1653; from which it may be conjectured that we owe this improvement to Lawes.

BAR, in *Hydrography*, denotes a bank of sand or other matter, whereby the mouth of a river is in a manner choked up. The term is also used for a strong beam wherewith the entrance of a harbour is secured; but this is more commonly called *boom*.

BAR-LE-DUC, an arrondissement of the department of

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Bar-le-
Duc.

Bar-sur-
Aube
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Barallots.

the Meuse, in France, extending over 560 square miles, comprehending eight cantons and 128 communes, and containing 75,580 inhabitants. The capital, a city of the same name, stands on the river Ormain, in a rich and beautiful district. It contains 1100 houses, with 9970 inhabitants. Long. 5. 50. E. Lat. 48. 46. N.

BAR-SUR-AUBE, an arrondissement of the department of the Aube, in France, extending over 461 square miles, and comprehending four cantons and ninety-two communes, with 37,500 inhabitants. The chief place is the city of the same name, in a district the wine of which is highly valued. It contains 4100 inhabitants. Long. 4. 44. E. Lat. 48. 13. N.

BAR-SUR-SEINE, an arrondissement of the department of the Aube, in France, extending over 648 square miles, comprehending five cantons and eighty-six communes, and containing 50,449 inhabitants. The chief place of the same name has a population of 2600 persons, employed in manufactures, and trading in the wine grown in its neighbourhood. Long. 2. 15. E. Lat. 48. 5. N.

BARA, the name of a festival formerly celebrated with much magnificence at Messina, and representing the assumption of the Virgin. Though used as the general denomination of this festival, bara signifies more particularly a vast machine fifty feet high, at the top of which a young girl of fourteen, representing the Virgin, stood upon the hand of an image of Jesus Christ.

BARABINZIANS, a tribe of Tartars, living on both sides of the river Irtisch. They seem to derive their name from the Barabaian desert, the lakes of which supply them abundantly with fish, on which and the products of their herds they chiefly subsist.

BARACOA, a town in the north-eastern part of the island of Cuba. Long. 74. 50. W. Lat. 20. 25. N.

BARA-FRANCA, a city in the intendancy of Calatanissetta, in the island of Sicily, with the largest convent of barefooted friars in the kingdom. It is on a gentle hill, in a healthy situation, and contains about 6000 inhabitants.

BARAHAT, a town of northern Hindostan, situated among the mountains of Serinagur. This town was almost destroyed by an earthquake in 1803; and from the houses having been built of large stones with slated roofs, the calamity was greatly aggravated. From its central position it maintains a free communication with all parts of the hills, and those who make the pilgrimage to Gangautri generally halt here, and lay in a stock of provisions for their journey. There is near this village a curious trident, the pedestal of copper, the shaft of brass about twelve feet, and the forks about six feet, in length. There is no tradition to show the origin of this curious relic of antiquity. Long. 78. 22. E. Lat. 30. 48. N.

BARAICHE, a town of Hindostan, in the province of Oude, and chief town of the district of Baraiche. It is finely situated on the river Sy, in long. 81. 36. E. lat. 27. 31. N. The district of Baraiche extends along the north side of the river Goggia, and is separated from the territories of Nepaul by a lofty range of mountains. A portion of this district was ceded to the English in 1800, but the greater part belongs to the nabob of Oude.

BARALIPTON, among logicians, a term denoting a syllogism of the first indirect mode of the first figure. Hence a syllogism in baralipon is when the first two propositions are universal affirmatives, the third a particular affirmative, and the middle term the subject in the first proposition, and the predicate in the second. For example,

BA. Every evil ought to be feared;

RA. Every violent passion is an evil;

LIP. Therefore something that ought to be feared is a violent passion.

BARALLOTS, in *Ecclesiastical History*, a sect of he-

retics at Bologna in Italy, who are said to have had all things in common, even their wives and children.

BARAN, a circle in the Austrian kingdom of Hungary, extending over 1681 square miles, or 1,075,840 acres. It lies at the south-east angle formed by the Danube and the Drave, and comprehends one city, seven towns, and 328 villages, with 223,400 inhabitants. The greater part of the land is fertile, but a portion of it is marshy and unhealthy. The chief products are corn, wine, flax, tobacco, and potash. There are some valuable quarries of marble and millstones, and many mines of fossil coal. It is subdivided into four smaller circles. The capital is Funfkirchen.

BARANGI, officers among the Greeks of the lower empire. Cujacius calls them in Latin *protectores*, while others give them the name of *securigari*. It was their business to keep the keys of the city gates where the emperor resided.

BARANWAHR, a town of Lower Hungary, in a county of the same name, taken by the emperor of Germany from the Turks in 1684. It is situated between Buda and Belgrade, in long. 18. 5. E. lat. 46. 0. N.

BARATHRUM, in *Antiquity*, a deep dark pit at Athens, into which condemned persons were thrown headlong. It had sharp spikes at the top, that no man might escape out; and others at the bottom, to pierce and torment such as were cast in.

BARATIERE, or BARETTIER, PHILIP, an extraordinary instance of the early and rapid expansion of the mental faculties. This surprising genius was the son of Francis Baratière, minister of the French church at Schwobach, near Nuremberg, where he was born on the 10th January 1721. The French was his mother tongue, together with some words of High Dutch; but in consequence of his father insensibly talking Latin to him, it became as familiar to him as his native idiom; so that, without knowing the rules of grammar, he, at four years of age, talked French to his mother, Latin to his father, High Dutch to the maid or neighbouring children, and all this without mixing or confounding the respective languages. About the middle of his fifth year he acquired Greek in like manner; so that in fifteen months he perfectly understood all the Greek books in the Old and New Testament, which he readily translated into Latin. When he was five years and eight months old, he entered upon Hebrew, and in three years became so expert in the Hebrew text, that from a Bible without points he could give the sense of the original in Latin or French, or translate extempore the Latin or French versions into Hebrew, almost word for word; he also acquired by heart all the Hebrew psalms. He composed at this time a dictionary of rare and difficult Hebrew words, with critical and philological observations; and, about his tenth year, amused himself for twelve months in reading the rabbinical writers. With these he intermixed the study of the Chaldaic, Syriac, and Arabic; and acquired a taste for divinity and ecclesiastical antiquity, by studying the Greek fathers, and the councils of the first four ages of the church. In the midst of these occupations a pair of globes having come into his possession, he was able in eight or ten days' time to resolve all the problems on them; and in about three months (January 1735) devised his project for the discovery of the longitude, which he communicated to the Royal Society of London and the Royal Academy of Sciences at Berlin. In June 1731 he was matriculated in the university of Altorf; and at the close of the year 1732 he was presented by his father at the meeting of the reformed churches of the circle of Franconia, which, astonished at his wonderful talents, admitted him to assist in the deliberations of the synod; and in order to preserve the memory of so singular

Baran
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Baratière.

Barbacan an event, it was ordered to be registered in their acts. In 1734 the margrave of Brandenburg-Anspach granted this young scholar the use of whatever books he wanted from the Anspach library, together with a pension of fifty florins, which he enjoyed for three years; and his father receiving a call from the French church at Stettin in Pomerania, young Baratière was, on the journey, admitted master of arts, with universal applause, at the university of Halle. While at Berlin he was honoured with several conversations with the king of Prussia, and received into the Royal Academy. Towards the close of his life he acquired a taste for the study of medals, inscriptions, and antiquities, which he relieved with metaphysical inquiries, and investigations in experimental philosophy. He wrote several essays and dissertations; made astronomical remarks and laborious calculations; prepared materials for a history of the heresies of the anti-trinitarians, and of the Thirty Years' War in Germany; and, lastly, wrote a treatise, which appeared in 1740, on the succession of the bishops of Rome. The final work he engaged in, and for which he had accumulated large materials, was *Inquiries concerning Egyptian Antiquities*. But the substance of this blazing meteor was now almost exhausted. He had always been weak and sickly, and he died on the 5th October 1740, aged nineteen years, eight months, and sixteen days. He published eleven different pieces, and left twenty-nine manuscripts on various subjects, the contents of which may be seen in his life, written by M. Formey, professor of philosophy at Berlin.

BARBACAN, or BARBICAN, an outer defence or fortification of a city or castle, used especially as a fence to the city or walls; also an aperture made in the wall of a fortress, to fire through upon the enemy.

BARBACAN is also used to denote a fort at the entrance of a bridge or the outlet of a city, having a double wall with towers.

BARBADOES, one of the Caribbees, is the most easterly of the West India islands, and the oldest colony of the British empire. It was probably discovered by Columbus or some of his companions, but they seem to have deserted it in pursuit of more splendid acquisitions; as, on the landing of the English in 1605, it was covered with thick forests, and destitute both of inhabitants and cultivation; they found a breed of swine, however, a proof of its having been previously visited. The favourable reports which these navigators gave of it on their return induced some enterprising Englishmen to plant a colony in it; and the island becoming a sanctuary for the royalists during the civil wars, it was rapidly peopled, and soon rose to great opulence. The earl of Marlborough obtained a grant of the island from James I.; and in 1627 it was made over by patent to the earl of Carlisle, from whom it was taken and given to the earl of Pembroke, but afterwards restored. When at the height of its prosperity, which was about the time of the restoration of Charles II., upon the planters appealing to the king, the earl of Carlisle was deprived of the hereditary proprietorship, and the legislation vested in the crown; the planters being confirmed in their possessions by submitting to a duty of four and a half per cent. on all the exported produce of the island; which tax is still continued, and is considered by the proprietors and merchants as an oppressive and vexatious impost.

Barbadoes is about twenty-one miles in length by nine of average breadth, and contains above 100,000 acres of land, of which 80,000 are under cultivation. The country is comparatively very level, and without the high central hills so frequent in the Antilles; the highest being only 1100 feet above the level of the sea. This is centrally situated, and called Mount Hillaby; the north-eastern part is hilly and bleak, and is in consequence called Scotland.

The primeval forests having at length been cleared away, Barbadoes. there is now a scarcity of wood throughout the island; although the proprietors, where they conveniently can, plant cocoa-nut, mahogany, and other tropical trees. The estates are said to average about 200 acres, and upon each of these there are a number of negro dwelling-houses, the planter's house, and a sugar-work; which, uniting with the great varieties of tropical trees and shrubs, form a scene highly picturesque, and give Barbadoes the appearance of a cluster of villages, and a characteristic beauty,—that of finished cultivation and domestic comfort. The soil covers a coralline rag, and has not only been long exhausted, but, being in general very thin, requires the utmost degree of manuring before it can be rendered productive. The mould varies in colour and quality according to the situation, but the black is considered best suited for the cultivation of the cane. Unlike the neighbouring islands, it is only very partially irrigated with one or two small streams; but the rains, which commence in May or June, and continue for several months, afford a sufficient supply of moisture. There are also a number of springs, but few of them good, the water being in general brackish. One of these casts up a bituminous matter called Barbadoes tar, which is useful in some complaints of cattle; and another of them emits a constant stream of sulphuretted hydrogen gas, which may be lighted with an ignited match. The productions of the soil are various, comprising all the fruits and other trees peculiar to such climates; but the article for which it is distinguished, and accordingly that by far the most extensively cultivated, is the sugar-cane. Ginger and aloes are also grown to a great extent; besides which maize and Guinea corn are raised in very considerable quantities; but no coffee plantations remain. There are upon the island a very great number of oxen, horses, and other cattle, which are not only valuable for the purposes of labour, but for the manure they supply. Oxen are in most general use, and only on the principal estates horses are employed.

Considerable numbers of hogs and poultry are reared, principally by the negroes, on the little plots of ground allotted them, by which provision their comforts are materially increased; the overplus goes to supply ships, or is exported to various neighbouring islands. Wild fowl, such as the plover and curlew, annually frequent the island in great numbers; and wild duck, teal, with many other descriptions of water-game, also abound in their season. The climate of Barbadoes is comparatively salubrious, and the hurricanes which frequently desolate the other islands have not visited it with any severity since the memorable one of 1780, which laid it waste.

Bridgetown, the capital, and the mart of commerce, lies on the south-west coast, in the interior of Carlisle Bay, and is about two miles in length by half a mile in breadth. The population exceeds 20,000. The city, without exhibiting much regularity or splendour in its buildings, possesses many handsome edifices, uniting elegance, convenience, and comfort in a higher degree than is to be found in any other of the English islands. There is a large and plain cathedral, with a number of other churches and chapels. Beyond the cathedral is the king's house, occupied by the commander of the forces on the station; a little farther in the country stands the government-house, called Pilgrim; and at the southern extremity of the town is the garrison of St Ann's, possessing large and spacious barracks, with a very fine parade ground. There are a number of charitable institutions in this town and throughout the island, particularly the central school, where white boys are educated upon the plan of the national schools of England, and another in the neighbourhood where girls are taught; besides which there are a

Barbara
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Barbary
States.

variety of seminaries for the tuition of coloured and slave children, several societies for the poor, and a house of industry where trades are taught; and all are well supported, either by government or the more opulent inhabitants. Libraries and literary societies have also been formed. Fourteen miles from Bridgetown stands the college, founded and liberally endowed by Colonel Codrington, where young men have not only the benefit of a university education, but receive orders, and are allowed to exercise their pastoral functions throughout the Leeward Islands. It is also intended to appropriate this seminary for the reception and instruction of catechists. Upon the estates of the college there is a chapel, a school, and an hospital, almost exclusively for the use of the negroes. There are three other towns on the island. Holetown lies about seven miles from the capital; it is very small, and only remarkable for being the first settlement of the English, who landed in the neighbourhood, and named their hamlet Jamestown, in honour of the first Stuart. Speight's Town, seven miles farther to the north, is a considerable place: it has a roadstead and wharf, and formerly exported sugar directly to England; but the practice is now to send it to Bridgetown, with which there is a daily communication by water. It possesses several religious houses, and some other neat buildings, with a considerable population, for the most part coloured. There is a fortress and signal station situated on Dover Hill, about half a mile from this place. The other town, called Oistins or Austins, is very inconsiderable; it stands a few miles to windward of the capital.

Barbadoes is peculiarly distinguished from most of the West India colonies, by the large quantity of provisions which is raised within the island, instead of depending upon foreign supplies. This is no doubt attributable to the crowded state of the population, to the traffic with the troops, and to many local circumstances consequent upon the great division of property. The exports of sugar are large, amounting on an average to 300,000 cwts. annually. Maize is also exported to the amount sometimes of 20,000 bushels yearly; besides rum, molasses, and other articles. The importations chiefly consist of articles of clothing, rice, corn, meal, flour, &c. and prepared wood, such as staves, shingles, lumber, and hoops; besides horses and oxen in very considerable numbers. Barbadoes lies twenty leagues east of St Vincent's, and sixty north-east of Trinidad. Long. 59. W. Lat. 13. 10. N. The population of the island in 1829, according to returns made to parliament, was as follows: whites, 14,959; free coloured, 3119; free black, 2027; slaves, 81,086.

BARBARA, among logicians, the first mode of the first figure of syllogisms. A syllogism in barbara is one of which all the propositions are universal affirmatives, the middle term being the subject of the first proposition, and the attribute in the second.

BARBARY STATES.

THE name of Barbary, or the Barbary States, is applied by the moderns to an extensive district, occupying, with the exclusion of Egypt, the whole northern coast of Africa. It comprehends also that portion of the western coast which lies to the north of the Great Desert. The states included within this district are entirely independent of and even hostile to each other, and they also differ in some particulars of their political constitution. There prevails, however, a striking similarity in the whole of their moral and physical circumstances. Throughout

BAR. Every wicked man is miserable;
BA. All tyrants are wicked men;
RA. Therefore all tyrants are miserable.

Barbarano
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Barbary
States.

BARBARANO, a town in the Austrian kingdom of Venetian Lombardy, in the delegation of Vicenza. Also the chief place of a district of the same name, at the foot of the Bernis Mountains.

BARBARIAN, a name given by the ancient Greeks and Romans to all who were not of their own country, or were not initiated in their language, manners, and customs. In this sense the word signified with them no more than foreigner; not, as among us, a rude or uncivilized person.

BARBARISM, in a general sense, a rudeness of language or behaviour.

BARBARISM, in *Grammar*, an offence against the purity of style or language, or a form of speaking or writing contrary to the true idiom of any particular language.

BARBAROSSA, ARUCH and HAYRADDIN, two famous corsairs, the sons of a potter in the Isle of Lesbos, who, turning pirates, carried on their depredations with such success and conduct, that they soon became possessed of twelve galleys besides smaller vessels. Of this fleet Aruch, the elder brother, called *Barbarossa* from the redness of his beard, was admiral, and Hayraddin the second in command. They called themselves the "friends of the sea," and the "enemies of all who sailed upon it;" and their names became terrible from the straits of the Dardanelles to those of Gibraltar. But with this power they wanted an establishment. The opportunity of settling themselves, however, presented itself in 1516, in consequence of an inconsiderate application made to them by Euteni, king of Algiers, for assistance against the Spaniards. Aruch, leaving his brother to command the fleet, carried 5000 men to Algiers, where he was received as a deliverer; and secretly murdering the prince he had come to aid, caused himself to be proclaimed king in his stead. To this usurpation he added the conquest of Tremecen, when his exploits and piracies induced the Emperor Charles V. to furnish the marquis de Gomarez, governor of Oran, with troops to put him down; which was accordingly done, as he was defeated and killed near Tremecen. His brother Hayraddin, known also by the name of Barbarossa, assumed the sceptre at Algiers with the same abilities, and with better fortune; for the Spaniards being too much employed in Europe to give him any disturbance, he regulated the interior police of his kingdom with great prudence, carried on his naval operations with vigour, and extended his conquests on the continent of Africa. He put his dominions under the protection of the Grand Signior, Suleiman the Magnificent, and obtained the command of the Turkish fleet. With so powerful a protector he acquired the kingdom of Tunis, in a manner similar to that by which his brother obtained Algiers.

all these states we see the same races inhabiting the towns, the plains, and the mountain districts; the same forms of social life; the same degraded and corrupted barbarism succeeding to ancient grandeur and civilization. Nature presents a corresponding similarity in all the peculiar qualities of aspect, soil, and climate. These resembling features constitute Barbary decidedly one region; and it will, therefore, be convenient to introduce here a general view of what is common to that region; while under the heads of Algiers, Morocco, Tripoli, Tunis,

Barbary States.

&c. will be given a view of the special history and circumstances of each.

This part of the world has at different periods been subject to memorable revolutions, and made a distinguished figure in history. It was the domain of Carthage, the most flourishing seat of commerce, and one of the most powerful states in antiquity,—of the prosperous Greek colony of Cyrene,—and of the potent kingdom of Numidia. Even when entirely subjected to the Roman power, it ranked as one of the most valuable provinces of that empire, and fully shared in the measure of civilization which its influence diffused. In a few centuries, however, it was overpowered by the barbarous torrent of Vandal invasion, when Genseric made Carthage the seat of a powerful piratical dominion. In the seventh century the rapid tide of Saracen inroad swept over the whole of this coast, and subjected it to the Moslem creed and institutions, which have remained unaltered to the present day. On the establishment, however, of the Turkish power on the eastern shores of the Mediterranean, the barbarous corsairs, Barbarossa and Dragut, seized the leading sea-ports upon this coast, and converted them into dens of the most atrocious piracy. This system was prosecuted without interruption for several centuries, till it was arrested by the interposition of the great European powers. France has even undertaken, with regard to the fiercest and most powerful of these states, a system of conquest and colonization, the result of which, however, remains yet to be decided, in as far, at least, as regards the latter.

Physical aspect.

Among the natural objects which this region presents, the most prominent is that immense and celebrated mountain chain which, under the name of Atlas, traverses nearly its whole extent. The loftiest portion is that which towers over the plain of Morocco, and, notwithstanding the intense heat of the climate, presents a range of summits clad in perpetual snow. The most recent traveller in this country, known by the name of Ali Bey, states that, after a very careful measurement, he found its highest pinnacles to rise 13,200 feet above the level of the sea. The lower stages are well cultivated and of luxuriant fertility; while, in ascending, the sides exhibit every variety of climate, from the torrid to the frigid zone. In skirting the kingdoms of Algiers and Tunis, its height is greatly diminished, and is represented by Dr Shaw as not exceeding the loftier eminences of our own island. The greater part of its declivity is here covered with vines and forests; and only occasionally a rocky precipice rears its head above the rest. This part of the range separates into various branches, differently named, of which the most elevated is Mount Jurjura, in the province of Algiers, covered with snow during a great part of the year. It forms a species of chain by itself, rising very high above all others east of Morocco. Besides the grand chain, there is found between it and the sea another, called the Little Atlas, extending from the Straits of Gibraltar to Bona in Algiers.

The structure and component parts of this vast range have been very imperfectly explored. It appears probable, however, that, as in other mountain groups of the first magnitude, the central mass, as well as the loftier pinnacles, is composed of granite. Ali Bey states, that the rocks on the coast consist of secondary granite, with sandstone resting on it; a combination which seems deserving of notice, from its resemblance to that which occurs at the southern extremity of Africa. Marble also is said to occur abundantly in the western regions. The lower and eastern branches appear, however, to contain a large proportion of calcareous rocks. The chain, considering its extent, is thought not peculiarly rich in metallic ores, though this character may have been derived

from the supine neglect of the inhabitants in exploring its mineral treasures. Silver and copper are procured to a considerable amount in the Tunisian territory. Algiers produces lead, and a small proportion of iron. Morocco contains no mines that are known or worked, unless in the province of Suse, the southern extremity of the empire. There, iron is found at Idaultit, and copper in considerable quantity in the vicinity of Tessellert. The report of gold and silver mines is treated as a fable by Chenier; but Jackson asserts that he saw evident traces of them in the neighbourhood of Messa. He also confirms the report of Leo, that the sovereigns of Morocco discourage the working of these mines, lest the natives, who at present can with difficulty be retained under the yoke, should thus be enabled to set them completely at defiance.

That narrow tract between the Atlas chain and the sea, which comprises the Barbary States, forms a plain of luxuriant fertility, traversed by innumerable streams descending from this mighty storehouse of waters. Chenier calculates that upwards of six thousand are poured down from the western Atlas upon the plains of Morocco. The vicinity, however, of the receptacle to their source prevents their forming rivers of any great magnitude. The principal are, in Morocco, the Seboo, the Morbeya, the Tensift, and the Suse; in Algiers, the Shelliff; in Tunis, the Mejerdah. The soil, which is naturally of the same loose and sandy character prevalent over northern Africa, is, by this profusion of moisture, rendered equal in fertility to any in the world. Its lightness is even beneficial, by rendering it capable of being worked with the utmost facility; so that, according to Dr Shaw, a yoke of oxen can plough an acre in the day. But wherever water fails, deserts are produced; presenting, on a smaller scale, the same appearances with those immense wastes which extend south of the Atlas. Thus the moisture which these mountains supply is the sole spring of fertility to northern Africa; and Tripoli, where they terminate, borders almost immediately on the sandy waste.

Along the southern base of the Atlas extends a vast region, called Bildulgerid, or more properly Bled-el-Jereed, *the dry country*. It presents a gradual transition from the luxuriant plains of Barbary to the sterile desolation of the Sahara. Large streams, descending from the great chain, traverse it from north to south, till they expand into lakes, or are lost in the sands of the desert. The moisture, evaporated by the scorching winds which blow from the south, is not sufficient for the production of wheat, barley, or the finer fruits: dates are its abundant and almost sole product. They form the food of its inhabitants, and the basis of their commerce. Considered in a political view, this region is nominally subject to those states of Barbary which lie in contact with it; but the subjection scarcely amounts to more than the payment of a certain tribute. The part contiguous to and dependent upon Morocco is known by the names of Tafilet and Sigilmessa.

The whole of Barbary abounds, in a very remarkable degree, with different species of saline substances. Common salt, particularly, is found in every form, and in the greatest abundance. That drawn from the mines of Morocco is of a red colour, very strong and coarse; but a white and finer kind is produced by evaporation on the sea-coast. The lakes of Barbary are almost all salt to an equal degree with the sea itself; and in the course of the summer many of these dry up entirely, leaving the mineral encrusted on their beds. Near the lake of Marks, in the Algerine territory, there is a mountain composed entirely of salt; and all the chains which traverse it contain copious repositories of this mineral. Most of the springs which are not warm are salt; and in the territory of Tunis

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there is no fresh water unless from rain. Many of the rivers, when they dry up in summer, leave their banks copiously encrusted with nitrous and saline exudations. Saltpetre is not found in a concrete state; but at Tlemsan, Kairwan, and many other places, the earth is so impregnated with it, that six ounces are obtained from a quintal of soil.

The Atlas Mountains, as far as is hitherto known, are not the seat of any volcanic eruptions. In East Barbary earthquakes are frequent during the hot and dry season, and have sometimes thrown down houses, and even carried them to a considerable distance; but these are rare instances, for their effects are by no means so terrible as in the south of Europe and other countries particularly exposed to their ravages. The interior heat, however, manifests itself by that which it communicates to a large proportion of the waters which flow through this territory. Most of the streams of the Jereed are at least lukewarm; and near Oran, Tlemsan, Gabs, and other places in the territory of Algiers, they acquire a temperature which fits them for warm baths. About forty miles to the east of Constantina are those called the Hamman Meskouten, the heat of which is so intense as to boil animal food in a quarter of an hour. The rocks over which this rivulet flows are entirely calcined by its influence, which, acting variously on the different substances, consuming some and leaving others nearly entire, produces some curious phenomena. The rocks at one place represent a line of regular cones, believed by the Arabs to be the tents of their ancestors converted into stone. At another place the action is still deeper and more irregular; the figures of sheep, horses, camels, even of men, women, and children, are presented to the eye, all of which are believed by the natives to have undergone the same transformation.

Vegetable
and animal
produc-
tions.

The productions of the soil in Barbary are not materially different from those of southern Europe, the climate being brought by the vicinity of the mountains to pretty nearly the same temperature. The grains chiefly cultivated are wheat and barley, of which the crops are abundant, though there is not above one in the year. Oats are not frequent, but beans and lentils are very common. Peas have been introduced by Europeans. Pot herbs and fruits are abundant, and nearly resemble those of Europe; with the addition, in the last branch, of the palm-tree and the lotus.

The animal world, particularly in its wild members, presents an interesting field of observation. The Numidian lion still retains its ancient character of strength and ferocity. To guard against its attacks, the villages and encampments are surrounded with a species of palisade, and upon the slightest alarm large fires are kindled; yet these multiplied precautions are not always sufficient to prevent the irruption of this lord of the forests. The animal called here a tiger is in reality only a panther. Wild boars are very numerous, and the hunting of them affords a favourite amusement. The hyena is common, and is called the *dubbah*. Jackson mentions an animal called the *aoudad*, which inhabits the most lofty and precipitous regions of the Atlas; but, on account of its rugged and inaccessible haunts, has never been sufficiently observed or described. The antelope, or gazelle, from its beauty, is the favourite of the Arabs. The Barbary females paint their eyes with a preparation of lead called *Elkahol-flelly*, in order that they may rival the largeness and blackness of those of the gazelle. Gazelle here, as angel with us, is the most flattering epithet that can be applied to female beauty. Although the antelope be the swiftest of all animals, he is soon fatigued, so that the greyhound at length comes up with him. The flesh is valued, and is

similar to venison. Among the smaller animals the most noted are the jerboa and jird, which are about the size of a rat, burrow in the ground, and afford agreeable food.

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Among birds, the chief is the ostrich, a species often described, and which occurs along the whole northern border of the desert. About Wedinoon and Cape Bojador they are said to be the largest, and to have the finest feathers, of any in the world. The feathers form a considerable article in the commerce of Morocco.

The serpent species is very numerous. The great boa constrictor frequently appears in the Sahara. It is not poisonous, and destroys merely by its strength and ferocity. There are several species which contain a very active poison; but these, Dr Shaw conceives, do not exist in that great variety which is enumerated by ancient writers. There are also domestic serpents, of a more harmless nature, never molested, and held even in a kind of veneration. The most destructive of this class are the scorpions, which swarm to such a degree that, in summer, they are often found in the beds. It is believed in Morocco that the flesh of this animal affords a cure for its bite; and most of the inhabitants on that account keep a bottle of scorpions preserved in olive oil. Shaw observes that those of Algiers and Tunis, to the north of the Atlas, are not very noxious, causing only a slight inflammation and fever; but that in the Sahara they are much larger, and their venom more malignant.

The insect tribe in this country presents a much more terrible enemy, the locust. This destructive insect is bred on the confines of the desert; but at irregular intervals, impelled by some unknown cause, its swarms take their direction towards the cultivated regions. They move in vast bodies, and with an order which resembles that of regular armies. The march is all in one direction, led by a chief, called by the natives Sultan Jeraad. All attempts to stop their course by digging deep pits or by kindling fires have proved abortive. The foremost, indeed, fall victims to these means of annoyance; but the vast mass behind, undismayed by the fate of their forerunners, continue to pour on, file after file, in close and uninterrupted succession. The fires are extinguished; the pits are filled up; and the husbandman abandons in despair all attempts to arrest their progress. Every thing green is thoroughly consumed; and the fields, from being clad in all the verdure of spring, assume at once the aspect of wintry desolation. This scourge sometimes continues for several years, and is not unfrequently followed by the still more terrible evil of plague. It forms a very inconsiderable compensation to the inhabitants, that they use the locusts as food, and in that view regard them even as a delicacy.

Insects.

The domestic animals do not differ materially from those of Europe, with the exception of the camel, which, though frequent in Barbary, belongs more properly to the desert. The excellence of the horse was formerly the boast of Numidia; and Barbary horses have been highly valued, even in modern times. But the breed is said to have degenerated, chiefly in consequence of the best horses being liable to be seized by persons in power. The ass, and still more the mule, are the animals chiefly employed in labour. The cows are small, and produce little milk. The sheep fed on the Atlas are often of exquisite flavour. The wool being left entirely to nature, is of various quality, some of it coarse, but some very fine. The goats of Morocco produce that species of leather, the softness and pliability of which cause it to be held in such high estimation.

Domestic
animals.

After surveying the aspect of nature, our attention is drawn to the ruins of ancient art. The whole extent of Algiers and Tunis, and even deep into the desert, is co-art.

Remains
of ancient
art.

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vered with the most superb monuments of Roman grandeur. Constantina (the ancient Cirta), Spaitla (Suffetula), El Gemme, and many other places, exhibit specimens of the architecture of that people in its highest perfection. The temple at Spaitla is considered by Bruce as the most perfect example of the composite order existing. It seems matter of regret, as well as of surprise, considering the general interest taken in these objects, that the drawings made by Bruce, or under his direction, though said to be very fine, should never have been given to the public. The remains of Carthage are entirely subterraneous, yet these still convey an idea of the greatness and industry of that celebrated capital. Of the immense aqueduct which conveyed water to the city from the distance of sixty miles, many hundred arches are still to be seen, and several cisterns, nearly entire, are used as habitations by the Arabs. A few years ago, in digging among the ruins of Utica, some labourers found a number of beautiful statues, some mutilated, but others in complete preservation. Among them were two of Tiberius and Augustus, the former very finely executed; also four female figures, two of them exquisite specimens of Grecian sculpture. The spirit of antiquarian research seems to be active among the Christian inhabitants of Tunis; and many, even of the poorer classes, are said to be in possession of medals, engraved stones, and other curiosities. These, however, by being dispersed, are in some measure lost to the public.

Different
classes of
inhabit-
ants.

The population of the Barbary States is made up of a number of distinct races. A particular survey of each will therefore be necessary, in order to afford any complete view of the subject.

The first and most numerous class are the Moors. This is a European term, derived from the ancient *Mauri*, of whom probably no traces are now to be found. It is applied to the inhabitants of the cities of Barbary, and the country in their immediate vicinity. Generally speaking, a Mahomedan city presents a uniform aspect. Everywhere the same silence and seclusion, the same absence of all gaiety, bustle, and animation; narrow and dirty streets, bordered on each side by lines of dead wall; every individual burying himself in the interior of his family, and shrouding his existence, as it were, from all other eyes; while the female sex, who in Europe form the ornament of society, are immured in the apartments of the haram, bought and sold almost as slaves. Withal, however, there is combined an outward deportment of great gravity, solemnity, and decorum, with which neither the sentiments nor actions are found to correspond. But this is more particularly true of the cities of Morocco; for in Algiers and Tunis, an unsettled government, and the habits of a seafaring life, have produced, especially in the lower orders, a greater appearance of activity and turbulence, though without any departure from the general tenor of oriental habits.

A collection of *Letters* has been published by a female relation of Mr Tully, formerly consul at Tripoli, which gives a very lively picture of the manners of a Barbary court, and particularly of female society. This she had peculiar access to observe, in consequence of the intimate footing on which she lived with the ladies of the palace. The wives of the pasha and the other grandees are generally Georgian or Circassian captives, who are purchased at Constantinople at an early age, and trained in all those accomplishments which fit them for the harems of the great. By the Mahomedan law, each individual may have four wives and an equal number of concubines; but there is one principal wife, who alone shares the sovereign power. She has usually the same origin with the others, and enters the haram as a slave, but succeeds, by address and superior powers of captivation, in raising herself to this envied dignity. It is unlawful for the daughters of the sovereign

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to marry a subject; and as they do not usually form alliances with foreign states, they have no resource but to marry Turks and renegadoes, the refuse of society. They thus often choose as companions for life persons unworthy even to appear in their company. Accordingly, the husband is ruled with the most absolute sway, and treated usually worse than their slaves; to all which he quietly submits, in consideration of the lucrative offices this connection secures his advancement to.

The toilet of a Moorish lady is said to be formed entirely after the ancient model. No dressing-table is used; but a number of slaves attend, to each of whom a different office is assigned. One plaits and perfumes the hair, another arranges the eyebrows, a third paints them, and so on. A profusion of the richest Arabian perfumes and scented waters is used, and powdered cloves in vast quantity are stuffed into the hair. The eyelashes, by a very tedious process, are painted black, and, by pulling out a number of the hairs, are formed into a particular shape. This operation, though attended with very acute pain, is cheerfully submitted to. In short, a Moorish lady cannot be fully dressed under several hours; and her appearance is then so completely altered, that her nearest relations could scarcely recognise her.

These ladies are represented, in the *Letters* alluded to, as by no means spending their time, as usually supposed, in listless indolence. It is their task to overlook the numerous slaves who grind, spin, and perform all the necessary domestic offices. They are particularly expected to superintend the culinary operations, in order to guard against poison, the administering of which at meals is not unusual in these countries. These cares, with those of their family, fill up the time of the more amiable and domestic members of the haram; whilst those of a lighter turn find full occupation in the difficult and dangerous intrigues to which their disposition prompts them. With a few exceptions, however, they seem tolerably cheerful; and the view which these *Letters* give of their character is, on the whole, favourable.

The inhabitants of the towns do not form a race by themselves, but are aggregated from the various races who inhabit, or have inhabited, the country districts; the Arabs, the Brebers, probably in part also the ancient possessors, and the Vandal conquerors of Northern Africa. All these have been cast into that mould which Moslem despotism invariably forms. There is, however, a peculiar race, called Andalousie, descendants of those Moors expelled from Spain by the stupid despotism of that government. They inhabit chiefly the northern cities of the empire of Morocco, pique themselves on their descent, and seem to retain somewhat of that pride of birth which was probably formed during their residence in Europe.

The sciences, which anciently formed the glory of the Saracen name, are now, throughout the whole of this region, entirely extinct. Instruments are still shown, which display the most exquisite mechanical skill; but they are preserved merely as antique curiosities, without any knowledge of the principles by which they were constructed. Astronomy does not extend to the construction of a sundial, nor chemistry beyond the making of rose-water. With regard to medicine, the estimation in which that science, once so flourishing, is held, may be judged from the emolument reaped by its professors. The fee of a physician scarcely ever exceeds sixpence, and the most serious operations are performed for a shilling. These humble practitioners, however, succeed tolerably when only external wounds are to be healed; but in all internal maladies it appears very doubtful whether more patients die of the disease or of the remedies administered.

The Jews form a numerous class throughout all the

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cities, both of Eastern and Western Barbary. They seem to exist there nearly on the same footing as in Europe during the middle ages, the objects of universal hatred, contempt, and derision, and their plunder the invariable resource, whenever the sovereign finds himself in pecuniary embarrassment. Yet their knowledge of trade, and entire devotion to it, have almost secured to them the monopoly of mercantile and money transactions; and they are thus enabled to make such enormous profits as induce them to endure all this oppression. In Morocco, however, long-suffering appears at length to have wearied out their patience, and their numbers have been considerably thinned. In the capital, they are not now supposed to exceed 2000. But no such diminution seems to have occurred in the other states. Tunis is calculated to contain above 15,000.

The country Moors, or those who cultivate the plains of Barbary, appear to differ very widely from the inhabitants of the cities. The property, or rather the occupation of land, is, as usual in despotic countries, much subdivided. The manners of the cultivators have been little observed, but they are said to be characterized by a peculiar degree of ignorance and simplicity.

The inhabitants of the pastoral districts intermediate between the sea-coast and the Sahara are known by the name of Arabs. They appear, in fact, to comprise such of the descendants of the conquerors of Barbary as have adhered to their original and native employments. They exhibit the same migratory habits, the same simplicity of life, and the same union of hospitality and plunder, which distinguish their countrymen in Arabia. The touch of despotism has, however, taken from them much of that sense of honour and dignity which elevate the latter above the common level of barbarous tribes. They live in tents, thirty or forty of which united form a camp or *douar*, under the command of a scheik; and the supremacy over a number of these camps constitutes a great scheik or emir. The tents are made by themselves, of camels' hair and the fibres of the palm-tree; and they are arranged generally in three concentric circles, around the habitation of the scheik. The cattle go out to pasture during the day, and are tended by the men and boys; at night they are brought within the circle of the tents, where they are further guarded by a number of vigilant dogs, which bark incessantly. The complexion of the Arabs is of a deep copper. The females possess beauty when young, but quickly lose it. They adorn themselves by puncturing and tattooing, practices unknown to the other inhabitants of Barbary. When the spot occupied by a *douar* is exhausted, they remove to another; the women are then conveyed in groups, generally of three upon the back of each camel; whilst the children, lambs, and kids, are lodged in panniers on the sides. The scheiks embrace every opportunity of acting independently; and whenever a weak government or civil war occurs, they immediately begin to plunder. Of all the inhabitants of Barbary, the Arabs are animated with the most bigoted zeal for the Moslem tenets, and the deadliest enmity to the Christian name. This disposition, the effects of which have been felt by all European visitors, has probably darkened somewhat beyond reality the picture drawn by them of these tribes.

From the inhabitants of the plains, we ascend to those of the mountain districts. The greater part of the declivity of the Atlas chain is cultivated by a very remarkable people, called the Brebers. They have been named also Brebes, Berebbers, Barbars; and from them the name of Barbary is supposed to be derived. They appear to be descended from the original possessors of this region; view themselves still as its rightful owners; and regard with boundless indignation all the other nations by whom it is now occupied. Their subjection has always been very

imperfect, the slightest injury being sufficient to drive them into rebellion. Their chiefs are elective, and they alone, in this part of Africa, have a government moulded into somewhat of a republican form. They bear an extremely warlike character, and excel the inhabitants of the plains in the management of fire-arms. The army of Morocco has often been completely defeated by them, and pursued to the gates of the capital. In general, however, they carry on war chiefly by surprise and ambuscade. The idea formed of them by the Saracen conquerors may be conceived by a passage in a celebrated Arabian writer, Bakoui, who gravely informs us that they are the offspring of the giant Goliah, whom they resemble in strength and wickedness. They are divided into various tribes, of whom the Errifi, inhabiting a province of the same name between Algiers and Morocco, are the most powerful and ferocious.

The Brebers are distinguished from the other inhabitants of Barbary by a language which has nothing in common with any of the rest. It is considered by Adelung as being the same, allowing for some variation of dialect, with that of the Tibboo, the Tuarick, and of all the indigenous population of this part of Africa. Marsden and Langlès have supposed it to be a corruption of the ancient Punic language; but Mr Pinkerton forcibly argues, that a language which has no abstract terms, none belonging to the arts and sciences, and no written characters, could scarcely be even a corruption of the language of a civilized people. Its high antiquity, however, cannot well be doubted.

The Shelluhs inhabit the southern parts of Morocco. They are smaller in stature than the Brebers, and in character somewhat less rude. In all other respects they exactly resemble, and may be considered as a branch of, that race. Some writers have asserted that their language is different; but the vocabulary given by Chenier, and the information of Dupuis, seem to leave no doubt that it is merely a dialect with very slight variations.

To these different classes we may finally add one which is not inconsiderable, namely, that of the negroes. Originally brought as slaves from Soudan and Timbuctoo, they have multiplied greatly, and have even risen to distinguished situations. The sovereigns of Morocco, unable, from the natural jealousy of despotism, to trust their own subjects, have placed their entire confidence in negro troops. These form the standing army of the empire, the body-guard of the sovereign, and the garrison of all the principal fortresses. Their pay is very limited, not exceeding a penny a day; but its smallness is compensated by the license in which they are allowed to indulge. A person well acquainted with Morocco being asked its amount, answered, "Whatever they can rob or steal." Muley Ishmael maintained nearly 100,000 of these troops. Their fidelity to their monarch is said to be exemplary. Negro slaves still continue to be imported in great numbers, particularly into Morocco.

The different states, however, have each features peculiar to itself, which will be noticed under their respective heads.

The political state of this extensive region has suffered no change from the lapse of time, and is that of a savage, uncontrolled, and turbulent despotism. In Turkey and the Asiatic empires, there are public bodies rendered venerable by religion, by law, and even by knowledge, who share and moderate the power of the despot. In Barbary there are none such; the will, or rather momentary caprice, of the sovereign, rules every thing. Yet the throne, though thus absolute, is not thereby rendered secure: resting on no basis, it is overturned by the slightest storm that arises. The death of a sovereign is almost

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invariably followed by disputed succession and civil war; so that tranquillity, the sole boast of despotism, is not even secured by it to this unfortunate country.

Religion.

The religion of Barbary is well known to be throughout Mahommedan, professed with a degree of rigour and intolerance unknown in any other region of the globe. There is not, however, as in Turkey, any great body, like the Ulema, to act as the depositary of its doctrines and influence. This power is here enjoyed by individuals who raise themselves, by personal merit or demerit, to the character of saints. Saints, in Morocco, almost share with the sovereign the power of the empire. Sidi Ali and Sidi Alarbi are the two most eminent reigning saints. Their consideration is chiefly supported by working miracles, and does not require any sacrifice of the pleasures of life. They indulge in all without reserve, and, besides the usual number of wives, keep numerous concubines. The districts in which these saints reside pay no taxes, and are subject to no authority except theirs; and they are perpetually surrounded by a body of armed men, to chastise their own enemies and those of the prophet. At some distance from Tripoli is a fortified village possessed by a saint, called the Lion, serving as an asylum for every species of criminals, even those who are guilty of high treason. Idiots throughout Barbary are generally reputed saints; and some, in order to maintain the reputation of sanctity, find it expedient to counterfeit the total absence of reason.

Amount of the population.

The population of Barbary has been very variously reported, and has never been fixed on any precise or authentic data. We shall collect the different statements made on the subject. Mr Jackson gives that of Morocco at 14,886,600, of whom the cities and towns contain 895,600, the provinces within Atlas 10,341,000, the Berebbers amount to 3,000,000, the Tafiets to 650,000. He states these numbers to be founded upon information extracted from the Imperial Register. They are quite improbable, and very far beyond any estimate formed by preceding travellers. Chenier does not conceive that the empire can contain above six millions; and some have even reduced the estimate as low as two. Mr Macgill heard the population of the Tunisian territory generally estimated at five millions, but is inclined to reduce the estimate to half that amount. Of these he supposes that 7000 may be Turks, 100,000 Jews, 7000 Christians; the rest Moors, Arabs, and renegadoes. The Algerine territory has been estimated at somewhat more than two millions and a half. Tripoli is reckoned by Ali Bey to contain two millions, which is probably beyond the truth. Of the great cities, Morocco is generally supposed to contain 30,000; Fez, by Jackson 380,000, by Ali Bey only 100,000; Tunis, by Mr Macgill 100,000, by Mr Blaquiere 130,000; Algiers, by Dr Shaw 117,000; Tripoli, by Mr Blaquiere 25,000, by Ali Bey only 15,000.

Commerce.

With a soil so fertile, and where manufacturing industry is in so low a state, the productions of the earth must form the staple articles of export. Barbary, in ancient, and even in modern times, has been the granary of southern Europe. More lately, however, this branch of trade has been nearly cut off by a general prohibition, in all the states, against the exportation of corn. The materials for export are thus reduced to fruits, gums, hides, wax, and the produce of the very few manufactures which flourish throughout these states. Of these Morocco leather is the most important. Fez is the place where this manufacture has been brought to the highest perfection; but it is also carried on in the other cities of Morocco, as well as those of Eastern Barbary. Fez is also distinguished by the manufacture of woollen haiks, a species of long cloths universally worn by the Moors when they go abroad; of sashes and

silk handkerchiefs; and of carpets, which are little inferior to those of Turkey. Tunis is famous for the manufacture of a species of conical woollen caps called scull-caps, universally worn, not only in Barbary, but over the Levant. This fabric formerly employed fifty thousand persons; but the manufacturers of Leghorn and Marseilles now imitate it, and succeed in underselling the Tunisians, though, in the quality of the stuff, the latter remain still unrivalled. Robes and shawls of woollen gauze are also made to a great extent. Concerning the manufactures of Algiers and Tripoli we have few details; but, with the exception of caps, they appear to be nearly similar to those of Tunis.

The caravan trade with the interior of Africa is chiefly carried on from Morocco and Tripoli. From the former it is very extensive. The caravans carry chiefly salt, tobacco, and European goods; and bring back slaves, ivory, and gold dust. Lempriere estimates the amount of the former at one million, the latter at ten millions; which, if at all correct, would imply that the profits on this trade are immense. The trade from Tripoli has been greatly diminished, in consequence of the pasha having embroiled himself with his Arab neighbours, who, occupying the route by which the caravans must pass, render the communication extremely precarious.

The European goods for which there exists a demand in the Barbary States are exceedingly various. They include more or less of almost every article, both of manufacture and of colonial produce. In the former class are such articles as, being of inferior quality, can be afforded at a cheap rate; Yorkshire cloths, particularly druggets and serges; muslins of the coarsest and cheapest sorts; coarse linens, particularly German. Raw silk and Spanish wool were imported to a great extent when their manufactures were more flourishing. French wines are imported into the eastern states, where the precepts of Mahomet are less rigidly observed. The other imports are tin and lead to a considerable extent, English being preferred; coffee, sugar, and the different kinds of spices; hardware, cutlery, toys, in some demand; also alum, vitriol, cochineal, gum-lac, and vermilion, for their manufactures.

The commerce of Eastern Barbary has hitherto been carried on chiefly from Leghorn and Marseilles. Louis XIV. established at the latter port a Royal African Company, which formed several establishments upon the coast of the Algerine province of Constantina. The objects were the corn trade and the coral fishery, which they shared at first with an English company already established; but the latter failing, the whole trade fell into the hands of the French. Their first establishment was at the *Bastion de France*, at the western extremity of Algiers; but this was abandoned, and they settled at La Cala, Bona, Il Col, and Tabarca. They paid L.4000 a year to the dey of Algiers, and 100 per cent. to the bey of Constantina, on the grain exported; in addition to which they were obliged to submit to various forms of extortion and humiliation. The continental war, and the extinction of the French naval power, threw a large proportion of this trade into the hands of the British; and Malta became the channel through which it was conducted. In 1806 the British government contracted with the dey of Algiers for the possession of La Cala, Bona, and Il Col; in consideration of which they stipulated to pay him the sum of 50,000 dollars (L.11,000 sterling). Mr Blaquiere, and other persons acquainted with this coast, are of opinion that very important advantages might be derived from this settlement. The coral fishery alone might employ 500 boats and 9000 men; besides which, there is a large export of hides, wax, and wool. It is added, that the

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slavery.

country produces ship-timber, particularly oak, of the best quality, and in inexhaustible abundance; and that excellent hemp and flax might be raised. The British government, however, never formed any establishment or derived any benefit from the privilege thus purchased. The coral fishery is carried on by a small number of French and Neapolitan boats; and the spirited attempts made by the merchants at Malta to open a communication with this quarter have been frustrated.

We shall finally consider these states under the view which has so justly excited the interest and sympathy of the British nation. Piracy, with the main view of capturing Christians as slaves, has for ages formed the main employment of the barbarous states situated along the Mediterranean. To be placed under the absolute control of the most brutal and corrupted of mortals, whom religious antipathy has besides divested of every human sympathy—without any law or earthly power to appeal to—the hopeless victims of brutal cruelty, and still more brutal voluptuousness;—this is certainly the most dreadful fate to which human beings were ever devoted. Yet such has been the fate of thousands of Europeans, among whom were often those who, from rank, sex, and cultivation of mind, must have been most keenly sensible of its horrors. Painful as the subject is, it seems indispensable to give some details which may illustrate the extent of the evil, and the necessity which existed for some arrangements to remedy it.

The most particular and authentic account of the treatment of slaves at Algiers is that given in the American work already alluded to. On the 23d October 1792, the ship *President* saw approaching an armed xebec, bearing Spanish colours till she came within gun-shot, when she instantly hoisted the bloody flag, and fired. Escape was now impossible; the xebec instantly put out a boat, with thirty armed men, who rowed furiously towards the vessel, and boarded it with the wildest shouts and outcries. No resistance being made, they began to strip the crew with a fury of avarice of which it was impossible to form an idea. Sometimes several fell upon one American, and fought over him for the clothes of which he was stripped. Having ransacked every corner, they then ordered the Americans to descend into the boat; and those who showed any hesitation were instantly knocked down and kicked over into it. On reaching Algiers the distribution took place. The dey first made his choice, which was formerly limited to an eighth of the whole, but at this time extended to as great a number as he chose to demand. For this purpose they were conducted to the palace, and drawn up in files along a court, where they passed under this review. Having made his selection, he dismissed the rest with the compliment, "Go, you Christian dogs, and eat stones." The youngest were employed in menial offices about the palace, the rest were put to work in the marine and in public buildings. Whenever a foreign vessel was in the port, they were loaded with thirty or forty pounds weight of chains, in order to prevent their escape. Their heaviest labour consisted in dragging immense stones from a neighbouring quarry, for the repair and enlargement of the mole. A body of Turks attended to urge them on, but gave no aid, unless by continually roaring out *Hyomoly*, "heave away," with a noise so tremendous, that it was heard at the distance of more than a league. At night they were locked up in two huge buildings called bagnios, the lower part of which was employed for shops, and the upper for the joint accommoda-

tion of the captives and of the wild beasts belonging to the dey. There was no bed in the place, and they were obliged to lie on the floor, till their own ingenuity enabled them to erect some humble substitute. The daily allowance of food was a pound of very bad bread and a small quantity of oil. Many sunk under this accumulation of distress, and were carried to the Spanish hospital, the only relief provided for their miseries. The sympathy of the American people having been at length excited by reports of their sufferings, they opened a negotiation, and, at the expense of nearly 800,000 dollars, procured the release of the captives.

The observations made by Captain Croker during his visit in 1815 agree with the narrative of the Americans, and prove that no improvement had taken place. At the period of his arrival, three hundred Christian captives had been driven in from Bona, exposed to such treatment that fifty died within six days after reaching Algiers. They were still employed in the quarries, and loaded with chains, as before. His description of the house in which they were locked up is, that, "if it had light," it would resemble those in which the West Indian negroes keep their pigs. When at peace with the great powers, their piracy is chiefly exercised on Naples and Sardinia, with whom they have always taken care to continue at war. European, and even English colours, are assumed to entrap the unfortunate victims. They frequently also make descents on the coast, and sweep away all the inhabitants, without distinction of age or sex. The Tunisians, at the commencement of the reign of the late bey, landed on the island of St Pierre, belonging to Sardinia, and carried off the whole population, amounting to upwards of a thousand. At Tunis and Tripoli the treatment of slaves is not so utterly inhuman as at Algiers. The most dreadful fate is that of those who are judged fit to be received into the harem of the prince, or any of his principal officers; which, in consequence of the depraved propensities here prevalent, is not confined to one sex. Of those who become the slaves of private persons, both at Tunis and Algiers, some are tolerably, and a few very well treated.

It is not easy to ascertain the precise extent to which this enormous evil existed. Mr Blaquiere, though he represents its horrors in the most glowing colours, considers the whole number of captives as amounting only to a thousand. Mr Macgill calculates two thousand in Tunis alone, and the Americans the same number at Algiers. The first estimate, however, is probably the more correct, as, by a calculation of the amount and rate of ransoms returned, the number in Algiers, at the time of Lord Exmouth's first expedition, appears to have been four hundred and fifteen.

For the measures by which, in each of the Barbary states, the system of piracy has been at last suppressed, and for the formation, in the greatest of these states, of a French colony, which promises to effect a remarkable change in the condition of this part of the African continent, the reader is referred to the separate articles on ALGIERS, TUNIS, &c.

See Shaw's *Travels*; Jackson's *Account of Morocco*; Macgill's *Account of Tunis*; Blaquiere's *Letters on Sicily*; Tully's *Letters*; Ali Bey's *Travels*; Keatinge's *Travels*; Appendix to Robert Adams's *Travels in the Interior of Africa*; *Account of Algiers, and of the Treatment of American Captives*, by James Wilson Stephens, of Philadelphia. (E.)

Barbary
States.

Barbastro ||
Barbeyrac. BARBASTRO, a city of the province of Aragon, in Spain, on the river Vero, near its junction with the Cinca. It is fortified, and has a cathedral and seven other churches, with several hospitals, and 6200 inhabitants, chiefly employed in tanning and currying leather. Long. 0. 20. W. Lat. 41. 54. N.

BARBATELLI, BERNARDINO, otherwise called *Po-chetti*, a painter of history, fruit, animals, and flowers, was born at Florence in 1542. He was the disciple of Ridolfo Ghirlandaio at Florence. His touch was free, light, and delicate, and the colouring of his objects inexpressibly true; and, besides his merit in this style of painting, the historical subjects which he designed from sacred or profane authors were much admired. He died in 1612.

BARBE, or BARB, is an old word, denoting the armour of the horses of the ancient knights and soldiers, who were accoutred at all points. It is said to have been an armour of iron and leather, wherewith the neck, breast, and shoulders of the horse were covered.

BARBEL. See ICHTHYOLOGY, *Index*.

BARBER, one who makes a trade of shaving or trimming the beards of other men for money. Anciently a lute, viol, or some such musical instrument, made part of the furniture of a barber's shop; which then used to be frequented by persons above the ordinary level of the people, who resorted to the barber either for the cure of wounds, or to undergo some chirurgical operation, or, as it was then called, to be *trimmed*, a word that signified either shaving or cutting and curling the hair;—these, together with letting blood, formed the ancient occupations of the barber-surgeon. As to the other important branch of surgery, the setting of fractured limbs, that was practised by another class of men called *bone-setters*, of whom there are hardly any now remaining. The musical instruments in his shop were for the entertainment of waiting customers, and answered the end of a newspaper.

BARBERINO, FRANCIS, one of the best poets of his age, was born at Barberino, in Tuscany, in the year 1264. As his mother was of Florence, he settled in that city, where his profession of the law, but especially the beauty of his poetry, raised him a very considerable character. The greater part of his works are lost; but that which is entitled *Documenti d'Amore*, being a moral poem calculated to instruct those in their duty who have a regard for glory, virtue, and eternity, has had a better fate. It was published at Rome in quarto in 1640, by Frederic Ubaldini, who prefixed a life of the author; and as the poem contains many words which had grown obsolete, he added a glossary to explain them, which illustrates the sense by the authority of contemporary poets. Barberino died in 1348.

BARBERINO, a town of Tuscany, in Italy, situated at the foot of the Appennine Mountains. Long. 12. 25. E. Lat. 43. 40. N.

BARBET. See ORNITHOLOGY, *Index*.

BARBEYRAC, JOHN, was born at Besiers, in Lower Languedoc, in 1674. He was successively professor of belles lettres at Berlin, of law and history at Lausanne, and of public law at Groningen. His death took place in 1729. He translated into French the two celebrated works of Pufendorf, his *Law of Nature and Nations*, and his *Duties of a Man and a Citizen*; to both of which he wrote excellent notes, and to the former an introductory preface. He translated also Grotius's treatise *De Jure Belli ac Pacis*, with large and excellent notes; several of Tillotson's *Sermons*; Cumberland's treatise on the *Law of Nature*; and various other works. He compiled a supplement, in five vols. folio, to the collection of treaties

named *Grand Corps Diplomatique*; and was the author of an original work entitled *Traité de Jeu*, 2 vols. 8vo.

BARBEZIEUX, an arrondissement of the department of Charente, in France, extending over 465 square miles, and comprehending six cantons and eighty-eight communes, with 51,279 inhabitants. The town, from which it takes its name, is in a mountainous situation, with 2152 inhabitants. Long. 0. 5. W. Lat. 45. 23. N.

BARBIERI, GIOVANNI FRANCESCO, otherwise called *Guercino da Cento*, an eminent historical painter, was born at Cento, a village not far from Bologna, in 1590. At first he was a disciple of Benedetto Gennari; but he afterwards studied for some time in the school of the Caracci, though he did not adopt the manner of that famous academy. He seemed to prefer the style of Caravaggio to that of Guido or Albano, imagining it impossible to imitate nature truly, without the assistance of strong lights and strong shadows; and on that principle the light was admitted into his atelier from above. His taste in design was natural, easy, and often grand, but without any extraordinary share of elevation, correctness, or elegance. Towards the decline of his life he observed that the clearer and brighter style of Guido and Albano had attracted the admiration of all Europe; and therefore he altered his manner, even against his own judgment. But he apologized for this conduct, by declaring, that formerly he had painted for fame and to please the judicious, but that now he painted to please the ignorant and enrich himself. He died in 1666. His best performance is the history of S. Petronilla, which is considered one of the ornaments of St Peter's at Rome.

BARBIERI, Paolo Antonio, da Cento, painter of still life and animals, was the brother of Guercino, and born at Cento in 1596. He chose for his subjects fruits, flowers, insects, and animals, which he painted after nature with a lively tint of colour, great tenderness of pencil, and a strong character of truth and life. He died in 1640.

BARBOUR, JOHN, the contemporary and in some respects the rival of Chaucer, is the author of a poem which may justly be described as a national work: it relates the exploits of a very heroic monarch, whose memory is still cherished by his countrymen, and it displays so conspicuous a union of talent and patriotism, that, after the lapse of nearly five centuries, it has not ceased to attract an uncommon degree of attention. The orthography of this poet's name is very unsettled; it is to be found under the different forms of Barber, Barbere, Barbar, Barbare, and Barbour. It evidently belongs to that very numerous class of names originally derived from trades or occupations; but as *Barbour* appears to have been the ancient orthography of the word denoting this particular trade, there is sufficient propriety in adhering to the form now so generally adopted, and writing the name Barbour instead of Barber. Those authors who aver that he was born at Aberdeen, and educated in the abbey of Aberbrothick, seem to have substituted conjecture for evidence; no document which can enable us to ascertain the place of his birth or education has yet been discovered. His birth has been referred to the year 1316. When he describes the person of Randolph, says Lord Hailes, he seems to speak from personal observation; and as Randolph died in 1331 and Barbour in 1396, the poet, if we suppose him to have reached the age of eighty, would have been fifteen years old at the period of that illustrious warrior's death.¹ This however is but a vague calculation, resting on no solid basis; for he neither professes to describe the person of Randolph from actual observation,

Barbe-
zieux
||
Barbour.

¹ Hailes's *Annals of Scotland*, vol. ii. p. 3.

Barbour. nor is his description so minute and graphic as to justify the inference that he must have acquired his knowledge in this manner. It has been suggested by Dr Jamieson, that the strongest presumption of his having been born at so early a period, is to be found in the circumstance of his being a dignitary of the church in the year 1357. If we suppose him to have been born in 1316, he may have obtained this preferment about the age of forty; and the same learned writer remarks that it must have required very powerful interest to obtain it at a much earlier period. We are not however sufficiently acquainted with the details of his personal history, to be enabled to estimate the probability of his rapid promotion; but, according to the canon law, he could be regularly appointed an archdeacon at the age of twenty-five.¹ We must therefore be content to leave conjectural dates as we found them, without attempting to decide whether he was born in 1316, 1326, or 1330; but more authentic notices of this venerable archdeacon have fortunately been preserved. On the 13th of August 1357, Edward III., on the application of the Scottish king, granted Barbour a safeconduct to visit the university of Oxford, accompanied by three students.² This instrument expressly mentions that they are to repair thither for the purpose of study, and of performing scholastic exercises; and it has been stated by a distinguished ornament of the university that Barbour studied there during the years 1357 and 1365.³ But as the safeconduct describes him as archdeacon of Aberdeen, we cannot so easily admit that he comes under the common denomination of an academical student, if by this term we understand a person subjected to college discipline, and following a prescribed course of study; nor is it unreasonable to conclude that the scholastic exercises were solely to be performed by the three scholars who accompanied him. That he completed his studies in this celebrated university, is however sufficiently probable, though it must apparently have been at an earlier period of life. We may venture to infer, that on the present occasion he repaired to Oxford, as many individuals still repair to it, for the purpose of conferring with learned clerks, and of consulting books which he had no opportunity of consulting at home; and such a document may therefore be regarded as an honourable testimony of his love of learning. Nor is it the only document of this kind. There is another safeconduct, dated on the 6th of November 1364, and authorizing the archdeacon of Aberdeen to visit England with four horsemen, in order to study at Oxford or elsewhere, as he may judge expedient;⁴ and a third, dated on the 30th of November 1368, authorizes him to travel through England with two servants and two horses, on his way towards France for the same purpose of study.⁵ On the 13th of September 1357, the bishop of his diocese had nominated him one of the commissioners who were to meet at Edinburgh, to deliberate concerning the ransom

Barbour. of the captive king;⁶ but as he must then have received his passport for Oxford, it is conjectured that this nomination was only intended as a compliment, and that the actual duty was to devolve on a coadjutor, who is named in the same instrument. On the 16th of October 1365, Edward had granted him permission to travel through England, with six companions on horseback, towards St Denis and other sacred places;⁷ an expression which seems to indicate that the object of his expedition was of a religious nature. After an interval of several years, his name occurs in another authentic record; namely, in the list of the auditors of exchequer, appointed on the 18th of February 1373, or, according to our present computation, 1374. Here he is described as archdeacon of Aberdeen, and "clericus probacionis domus domini nostri Regis;" and in the same commission we find the name of Sir Hugh Eglintoun.⁸

About this period, he was engaged in the composition of the work which has transmitted his name to posterity; for it appears from his own statement that in the year 1375 his work was more than half-finished.⁹ Dr Henry has stated, but apparently without any competent authority, that it was undertaken at the request of David II., the son and successor of the heroic monarch whose actions the author commemorates; and that a considerable pension was granted to him as an encouragement to prosecute this design.¹⁰ It is to be recollected that David died in 1371, several years before Barbour had written one half of his poem. The history of his pension was involved in much obscurity, which has at length been removed by the researches of Dr Jamieson. Hume of Godscroft had affirmed that his merit as the author of this poem was rewarded by a pension from the exchequer during his life, that he transferred this pension to the hospital of Aberdeen, and that it still continued to be paid in his own lifetime.¹¹ The terms of this statement are evidently at variance with each other; but the fact of his having received a pension, or rather two different pensions, from the crown, rests on unquestionable authority; and this fact cannot but be regarded as creditable to the government of his country, nor must the extent of such liberality be estimated by so fallacious a standard as the present value of money. At a much later period, Hector Boyce enjoyed a revenue of forty marks, as principal of King's College, Aberdeen. Barbour's pensions consisted of ten pounds payable from the customs of Aberdeen, and twenty shillings payable from the rent of the lands and fisheries which that city held of the crown.¹² The first was merely an annuity for his life, but the other was granted to him and his assignees, with an express permission to dispose of it in mortmain; and it appears from the records to have been granted by Robert II. as a reward for the composition of his historical poem.¹³ This sum he did not bequeath to the hospital, but to the dean and chapter of Aberdeen, under the condition that they

¹ *Decretalia Gregorii IX.* lib. i. tit. vi. cap. vii. §. 2.

² Warton's *Hist. of English Poetry*, vol. ii. p. 154. Price's edit.

³ *Rotuli Scotiae*, tom. i. p. 886.

⁴ Rymer, *Fœdera*, tom. vi. p. 39.

⁵ *Accounts of the Great Chamberlains of Scotland*, vol. ii. p. 19.

⁶ Rymer, *Fœdera*, tom. vi. p. 31. *Rotuli Scotiae*, tom. i. p. 808.

⁷ *Rotuli Scotiae*, tom. i. p. 926.

⁸ Rymer, tom. vi. p. 478. *Rotuli Scotiae*, tom. i. p. 897.

⁹ And in the tyme of the compiling
Off this buk, this Robert wes king,
And off his kynrik passit was
Fyve yer; and wes the yer off grace
A thousand, thre hundyr, sevynty
And fyve, and off his eld sixty. (Barbour's *Bruce*, p. 274, Jamieson's edit.)

¹⁰ Henry's *Hist. of Great Britain*, vol. iv. p. 472.

¹¹ Hume's *Hist. of the Houses of Douglas and Angus*, p. 31. Edinb. 1644, fol.

¹² *Accounts of the Great Chamberlains of Scotland*, vol. ii. p. 128. 153.—With respect to these pensions, many subsequent entries occur.

¹³ *Ibid.* vol. iii. p. 269. Jamieson's *Memoir of the Life of Barbour*, p. viii.

Barbour. should say a yearly mass for the repose of his soul.¹ His larger pension seems likewise to have been conferred by the same king; and although this circumstance has not been traced in any record, it was probably conferred for the same reason.

Although the *Bruce* is the only work of Barbour that is known to be extant, it is not the only work of which he was the author. He appears to have written another book, doubtless in rhyme, comprising a genealogical history of the kings of Scotland, and deducing their origin from the Trojan colony of Brutus.² We may venture to conclude that his principal materials were drawn from very dubious sources; but although the historical value of this production may not have been very conspicuous, it would undoubtedly have been regarded as a curious relique of the literature of the middle ages. The existence of such a work is fully established by various passages in Winton's chronicle.

This Nynus had a sone alsua,
Sere Dardane lord of Frygia.
Fra quham Barbere sutely
Has made a propyr Genealogy,
Tyl Robert oure secownd kyng,
That Scotland had in governyng.³

Of Bruttus lyneage quha wyll her,
He luk the tretis of Barbere,
Mad in-tyl a Genealogy
Rycht wele, and mare perfytly
Than I can on ony wys
Wyttht all my wyt to yowe dewys.⁴

It is apparently the same book which the prior of Lochleven repeatedly quotes under the title of the Brute; and we agree with Dr Jamieson in thinking it highly probable that this book is quoted by Barbour himself in the subsequent passage.

Als Arthur, that throw chevalry
Maid Bretane maistres and lady
Off twelf kinrykis that he wan;
And alsua, as a noble man,
He wan throw bataill Fraunce all fre,
And Lucius Yber wencusyt he,
That then of Rome was emperour;
Bot yeit, for all his gret valour,
Mordreyt his systir son him slew,
And gud men als ma than inew,
Throw tresoune and throw wikkittnes;
The Broite beris thair off wytnes.⁵

The archdeacon, as has already been hinted, died in 1396;⁶ and as he had enjoyed his preferment for at least thirty-nine years, he must evidently have reached an advanced period of life. His character, if we may be allowed to form a conjecture from the general strain of his work, was of an amiable kind; and his name has long been respected by his countrymen. The earliest edition of the *Bruce* which has hitherto been traced was published at Edinburgh in 1616; but, as Patrick Gordon, whose poem was licensed in 1613, describes it as "the old printed book,"⁷ there is reason to believe that the first impression

is of a much earlier date. Several other editions appeared in the course of the seventeenth century; "and there are many later editions of no value, published by different booksellers, to answer the demand of the common people for this book; which, to the credit of their good sense, is very great."⁸ A more elaborate edition was at length published by Mr Pinkerton, from a manuscript in the Advocates Library; but as the transcript was neither executed by himself, nor under his immediate inspection, many gross inaccuracies were suffered to escape.⁹ After an interval of thirty years, another edition, the best that has yet appeared, was published by Dr Jamieson from a more careful collation of the same manuscript.¹⁰ This appears from the colophon to have been transcribed in 1489, by John Ramsay, who is supposed to be the same person that was afterwards prior of the Carthusian monastery at Perth. The transcript was executed at the request of Simon Lochmalony, vicar of Moonsie; and thus every individual more immediately concerned, the poet, the copyist, and his employer, belonged to the church.

When we endeavour to appreciate the literary merit of Barbour, we must at the same time endeavour to transport ourselves to the remote and unrefined age in which he lived; we must recollect the general barbarism of many preceding centuries, the difficulty of acquiring liberal knowledge, the rude and grotesque taste of almost all his contemporaries. When all these circumstances are duly considered, his poem will be found entitled to an ample share of our approbation. Fortunate in the choice of a subject, he has unfolded a series of remarkable events, and has diffused over a very long narrative that lively interest which an ordinary writer is incapable of exciting. Here we are not to expect the blandishments of modern poetry: the author stands conspicuous amid the ruins of time, and, like an undecayed Gothic tower, presents an aspect of majestic simplicity. The lively strain of his narrative, the air of sincerity which he always exhibits, his earnest participation in the success or sufferings of his favourite characters, as well as the splendid attributes of the characters themselves, cannot fail of arresting the attention of every reader familiarly acquainted with the language in which he writes. The age of the great King Robert was the age of Scottish chivalry, and the monarch himself presented the most perfect model of a valiant knight. Whatever inconsistencies may have appeared in his early conduct, the best portion of his life was undoubtedly spent in the exercise of heroic valour or of political wisdom. Such a hero and such a crisis were a most fortunate selection; and although the intrinsic merit of the poet is very conspicuous, yet the attraction of the poem is partly to be ascribed to his judicious choice of a subject.

Barbour was evidently skilled in such branches of knowledge as were then cultivated, and his learning was so well regulated as to conduce to the real improvement of his mind: the liberality of his views, and the humanity of his

¹ *Accounts*, vol. ii. p. 402.

² With respect to the story of the Trojan origin of another nation, "Ueber die Sage von der Trojanischen Abkunft der Franken," some curious notices may be found in W. C. Grimm's *Altdeutsche Heldenlieder, Balladen, und Märchen*, S. 431. Heidelberg, 1811, 8vo.

³ Winton's *Cronykil of Scotland*, vol. i. p. 26.

⁴ *Ibid.* vol. i. p. 54.—Another early poet mentions Barbour as the author of different works.

Master Barbour, quhilk was a worthi clerk,
He said the Bruce amang his othir werk. (Henry's *Wallace*, p. 353.)

⁵ Barbour's *Bruce*, p. 20.

⁶ *Chartulary of Aberacene*, f. 115.

⁷ Gordon's *Famous Historie of the renounea and valiant Prince Robert, surnamed the Brose, King of Scotland*. Dort, 1615, 4to.

⁸ Pinkerton's *List of the Scottish Poets*, p. lxxxiii.

⁹ *The Bruce; or, the History of Robert I. King of Scotland*: written in Scottish verse by John Barbour. The first genuine edition, published from a manuscript dated 1489; with notes and a glossary by J. Pinkerton. Lond. 1790, 3 vols. 8vo.

¹⁰ *The Bruce and Wallace*; published from two ancient manuscripts preserved in the Library of the Faculty of Advocates: with notes, biographical sketches, and a glossary. Edinb. 1820, 2 vols. 4to.

Barbour. sentiments, appear occasionally to have been unconfined by the narrow boundaries of his own age. He has drawn various illustrations from ancient history and from the stories of romance, but has rarely displayed his erudition by decking his verses with the names of ancient authors: the distichs of Cato,¹ and the spurious productions of Dares Phrygius and Dictys Cretensis are the only profane books to which he formally refers. He has borrowed more than one illustration from Statius, who was the favourite classic of those times, and who likewise appears to have been the favourite of Barbour: the more chaste and elegant style of Virgil and Horace was not so well adapted to the prevalent taste, as the strained thoughts and gorgeous diction of Statius and Claudian. The manner in which he has incidentally discussed the subject of astrology and necromancy, may be specified as not a little creditable to his good sense. It is well known that these branches of divination were assiduously cultivated during the ages of intellectual darkness. The absurdity of astrology and necromancy he has not openly attempted to expose; for as the opinions of the many, however unfounded in reason, must not be too rashly stigmatized, this might have been too bold and decided a step. Of the possibility of predicting events he speaks with the caution of a philosopher; but the following passage may be considered as a sufficient indication of his deliberate sentiments:

And sen thai ar in sic wenyng,
For owtyne certante off witting,
Me think quha sayis he knawis thingis
To cum, he makys gret gabingis.²

To form such an estimate, required a mind capable of resisting a strong torrent of prejudice; nor is it superfluous to remark, that in an age of much higher refinement, Dryden suffered himself to be deluded by the prognostications of judicial astrology.³ It was not however to be expected that Barbour should on every occasion evince a decided superiority to the general spirit of the age to which he belonged. His terrible imprecation on the person who betrayed Sir Christopher Seton, "In hell condampnyt mot he be!" ought not to have been uttered by a Christian priest. His detestation of the treacherous and cruel King Edward induced him to lend a credulous ear to the report of his consulting an infernal spirit. The misfortunes which attended Bruce at almost every step of his early progress, he attributes to his sacrilegious act of slaying Comyn at the high altar. He supposes that the women and children who assisted in supplying the brave defenders

of Berwick with arrows and stones, were protected from injury by a miraculous interposition. Such instances of superstition or uncharitable zeal are not to be viewed as marking the individual: gross superstition, with its usual concomitants, was the general spirit of the time; and the deviations from the ordinary track are to be traced in examples of liberal feeling or enlightened judgment.

His encomium on political freedom is distinguished by a manly and dignified strain of sentiment:

A! fredome is a noble thing!
Fredome mayss a man to haiff liking
Fredome all solace to man giffis:
He levys at ess that frely levys.
A noble hart may haiff nane ess,
Na ellys nocht that may him pless,
Gyff fredome failyhe; for fre liking
Is yharnyt our all othir thing.
Na he that ay hass levyt fre,
May nocht knaw weill the propyrtie,
The angyr, na the wrechyt dome
That is cowplyt to foule thyrdome.
Bot gyff he had assayit it,
Than all perquer he suld it wyt,
And suld think fredome mar to pryss
Than all the gold in warld that is.⁴

From the satisfaction with which the poet seems to contemplate any example of the gentler virtues, we may venture to draw a favourable inference respecting the native benevolence of his disposition. The subsequent passage cannot be passed without particular notice: the annals of heroes furnish but few instances of so pleasing a nature, whether it be that heroes seldom stoop to actions of mere benevolence,⁵ or that their historians do not think it of much importance to transmit such actions to posterity.

The king has hard a woman cry;
He askyt quhat that wes in hy.
"It is the layndar, Schyr," said ane,
"That her child-ill rycht now has tane,
"And mon leve now behind ws her;
"Tharfor scho makys yone iwill cher."
The king said, "Certis it war pite
"That scho in that poynt left suld be;
"For certis I trow thar is na man
"That be ne will rew a woman than."
Hiss ost all thar arestyt he,
And gert a tent sone stentit be,
And gert hyr gang in hastily,
And othyr wemen to be hyr by,
Quhill scho wes deliuer, he bad,
And syne furth on his wayis raid:
And how scho furth suld caryit be,
Or euir he furth fur, ordanyt he.

¹ And Catone sayis ws in his wryt,
That to fenyhe foly quhile is wyt. (Barbour's *Bruce*, p. 13.)

This passage evidently refers to the collection of distichs which bears the name of Dionysius Cato, whom Chaucer likewise calls Caton or Cathon; a circumstance which, as Mr Warton remarks, shews that he was more familiarly known from the French translation than from the Latin original.

Insipiens esto quum tempus postulat aut res:

Stultitiam simulare loco, prudentia summa est. (Catonis *Disticha*, lib. ii. 18.)

This work of Cato was held in the highest estimation during the middle ages, and it has been translated into Greek, Anglo-Saxon, German, French, and English. It comprehends a series of moral lessons, which are often conveyed with a considerable degree of terseness and compression. The author possesses so much purity of diction, that Joseph Scaliger supposes he cannot have flourished subsequently to the reign of Commodus or Severus; and Hen. Cannegieter, who was alike conversant with philology and the civil law, has employed several arguments, drawn from the history of the Roman jurisprudence, to prove that this poet must at least have preceded the reign of Constantine. (*Rescripta Boxhornii de Catone*, cap. xviii.) Cato, for example, speaks of divorcing a wife, if she should become troublesome, "si cœperit esse molesta." (Lib. iii. 13.) But after the law of divorce had been modified by that emperor, it was not competent for a husband to dismiss his wife, merely because he did not find her agreeable. (*Codex Theodosianus*, lib. iii. tit. xvi.) The most complete edition of Dionysii Catonis *Disticha de Moribus ad Filium*, is the second published by Otto Arntzenius. Amst. 1754, 8vo. It contains the notes of many learned commentators, the Greek versions of Planudes and Scaliger, with the dissertation of Boxhornius, and the very copious reply of Cannegieter.

² Barbour, p. 88.

⁴ Barbour, p. 10.

⁵ Johnson's *Lives of English Poets*, vol. ii. p. 109.

⁵ Οἱ γὰρ ἥρωες—
Κακοῦν ἵτοιμαί μᾶλλον ἢ εὐεργετοῖν. (Menandri *Fragmenta*, p. 158. edit. Meineke.)

Barbour.

This wes a full gret curtasy,
That swilk a king, and sa mighty,
Gert his men duell on this maner
Bot for a pour lauder.¹

Barbour seems to have been acquainted with those nicer springs of human action which elude vulgar observation; he catches the shades of character with a delicate eye, and sometimes presents us with instances of nice discrimination. His work is not a mere narrative of events; it contains specimens of that minute and distinct delineation which marks the hand of a skilful artist. An illustration of this remark may perhaps be found in the following incident. When Bruce has with his single arm defended a narrow pass against a party of two hundred Gallovidians, his soldiers are represented as flocking around him with the same eager curiosity as if they had never had another opportunity of seeing him.

Syk wordis spak thai of the king,
And for his hey wnder taking
Farlyit, and yaryt hym to se,
That with hym ay wes wont to be.²

In the opinion of an exquisite critic, Barbour has adorned the English language by a strain of versification, expression, and poetical imagery, far superior to the age.³ And Dr Nott remarks that he "had given his countrymen a fine example of the simple energetic style, which resembled Chaucer's best manner, and wanted little to make it the genuine language of poetry."⁴ The best method of estimating the merit of his versification, will be to compare it with that of some English poet who flourished about the same period; and, if placed in competition with the versification of Chaucer, Gower, or Lydgate, the most celebrated English poets of that era, it must certainly be admitted to appear with sufficient advantage. Although a general conclusion cannot safely be drawn from a particular instance, it may yet be worth while to compare the following quotations from Chaucer and Barbour:

The byrdes that han lefft her songe,
Whyte they han suffred colde full stronge
In wethers grylle, and derke to syght,
Ben in May, for the sunne bryght,
So glad that they shewe in syngyng
That in her herte is suche lyking,
That they mote syngen and ben lyght:
Than doth the nyghtyngale her myght
To maken noyse and syngen blythe;
Than is blyssfull many a sythe
The chelaundre and the popyngay;
Than yonge folke entenden aye
For to ben gay and amorous,
The tyme is than so sauorous.⁵

This wes in ver, quhen wynter tid,
With his blastis hidwyss to bid,
Was our drywyn, and byrdis smale,
As turturis and the nyghtyngale,
Begouth ryght sariely to synge,
And for to mak in thair singyng
Swete notis, and sownys ser,
And melodys plesand to her;
And the treis begouth to ma
Burgeans, and brycht blomys alsua,
To wyn the helyng off their hewid,
That wykkyt wyntir had thaim rewid.⁶

Here the versification of Barbour is certainly not inferior to that of Chaucer; but we have no intention to aver that

the general merit of the two poets is equal. Chaucer has attempted a great variety of subjects, and, for the most part, with eminent success. His measures are also varied; and, if we compare his versification with that of preceding poets, or indeed with that of his immediate successors, it will be found entitled to high commendation. He reformed the taste and improved the language of his native country. The merit of Barbour, though more circumscribed, is yet so eminent as to entitle him to a very honourable place in the history of British poetry.

The style of this poet is distinguished by its terseness, and he often exhibits a happy brevity of expression. His work contains a greater proportion of French idioms than we discover in the writings of the preceding Scottish poets, though their positive number is far from being considerable. Fiction is not inseparably connected with verse. The historical merit of Barbour's poem has been admitted by very competent judges; and, among others, Lord Hailes has repeatedly acknowledged the general fidelity of his narrative. King Robert died in 1329; and, as Barbour was employed in writing his poem within forty-six years from that period, he must have enjoyed many opportunities of collecting information. He might himself have conversed with warriors who fought at Bannockburn; and on one occasion he quotes the authority of a valiant knight, Sir Allan Cathcart, who was personally engaged in a particular exploit which he is about to relate.

A knyght, that then wes in his rowt,
Worthi and wycht, stalwart and stout,
Curtaiis and fayr, and off gud fame,
Schyr Alane off Catkert by name,
Tauld me this taile, as I sall tell.⁷

Of the general merit of Barbour's work, so favourable an estimate has been formed by Mr Pinkerton, that it may not be improper here to produce his testimony. "Perhaps the editor may be accused of nationality, when he says, that, taking the total merits of this work together, he prefers it to the early exertions of even the Italian muse, to the melancholy sublimity of Dante, and the amorous quaintness of Petrarca, as much as M. Le Grand does a *fabliau* to a Provençal ditty. Here indeed the reader will find few of the graces of fine poetry, little of the Attic dress of the muse; but here are life, and spirit, and ease, and plain sense, and pictures of real manners, and perpetual incident, and entertainment. The language is remarkably good for the time, and far superior in neatness and elegance even to that of Gawin Douglas, who wrote more than a century after. But when we consider that our author is not only the first poet, but the earliest historian of Scotland, who has entered into any detail, and from whom any view of the real state and manners of the country can be had; and that the hero whose life he paints so minutely, was a monarch equal to the greatest of modern times; let the historical and poetical merits of his work be weighed together, and then opposed to those of any other early poet of the present nations in Europe."⁸ (x.)

BARBUDA, one of the Caribbee islands, is 21 miles in length by about 12 in breadth, presenting a very flat surface, covered to a great extent with forests of small trees, in which excellent deer abound. Many varieties of very fine shell and other fish are found on the coast, which is

Barbour
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Barbuda.

¹ Barbour, p. 320.

² Barbour, p. 118.

³ Warton's *History of English Poetry*, vol. ii. p. 154.

⁴ Nott's *Dissertation on the State of English Poetry before the sixteenth Century* (p. cxc.), prefixed to the Works of Surrey and Wyatt. Lond. 1815, 2 vols. 4to.

⁵ Chaucer's *Romaunte of the Rose*: Workes, f. cxxviii. edit. Lond. 1542, fol.

⁶ Barbour, p. 80.

⁷ Barbour, p. 183.

⁸ Pinkerton's *Preface to Barbour*, p. x.

Barca
||
Barcelona.

also frequented by large flocks of water-game. The part of the island cultivated is fertile, but there is no sugar raised, nor are there any plantations of importance, the labour consisting principally in raising provisions, building droghens, and rearing cattle, with which some of the neighbouring islands are supplied. Barbuda possesses no towns, but negro hamlets are scattered over its surface, and a church has lately been erected. The climate is salubrious, and invalids resort thither from other parts of the West Indies. This island is the entire property of the Codrington family. It is situated 12 leagues to the north-east of Antigua, and 24 to the north-north-east of St Christophers, and contains a population of about 1000 inhabitants. Long. 61. 46. W. Lat. 17. 36. N.

BARCA, the name which has been given by the Arabs to an extensive country between Tripoli and Egypt, occupying the site of the ancient Cyrenaica. It is from this identity, and from the monuments which it presents, that the region in question is now chiefly interesting. Indeed, since the important expeditions of Pacho and Beechey have made us well acquainted with the country, it is under the classic name that it is almost exclusively recognized. We shall therefore describe it and its ancient monuments under the head of CYRENAICA.

BARCELLOS, a city of the province of Entre-Douro-e-Minho, in the kingdom of Portugal. It is on the river Savado, is fortified, and contains a population of 5000 persons, who, in the fertile district around them, cultivate the celebrated white wine which takes the name of the city.

BARCELONA, a city of Spain, the capital of the province of Catalonia. It is situated on the shore of the Mediterranean Sea, between the mouths of the river Besos and the Llobregat, about one mile from each, on a plain of great fertility, covered with gardens and country houses. The city is but imperfectly fortified; but it is defended by the fortress of Montjuic, which commands every part of it. The buildings are irregular, and most of the streets narrow; but some of the plazas or squares, especially that of the Pallacio and the Born, are very respectable. It contains a Gothic cathedral of majestic appearance, 92 other churches, 37 monasteries, 7 hospitals, and about 11,000 houses; and, including the suburb Barcelonetta, about 140,000 inhabitants. There are here various institutions for the education of medical practitioners, one for mathematical tuition, and one for navigation. It was a place of considerable manufactures, but the loss of the South American colonies has injured that kind of industry, and lessened the tonnage of ships that have entered and left the port. The vessels that cleared out in 1816 were 1231, and in 1826, 1009. There is here a naval arsenal, a light-house, a foundery for cannon, and extensive barracks. Long. 2. 5. 55. E. Lat. 48. 23. 8. N.

The Spaniards, who are proud of the antiquity of their cities, ascribe the founding of Barcelona to the Carthaginians under Hamilcar, and the name to Borcino, a general of that nation. It was the theatre of hostilities, both during the government of the Moors in Spain, and in the wars subsequent to that period. During the War of the Succession it adhered to the house of Austria; and, at the close of it, was reluctantly reconciled to the dynasty of the Bourbons. At the commencement of Buonaparte's attempt to seize on the government of Spain, the French

troops obtained possession of the fortress, which commands the city; and thus, during the continuance of that war, it was held in most unwilling subjection to the enemies of the cause which its inhabitants most zealously espoused.

BARCELONETTE, an arrondissement of the department of the Lower Alps, in France, 472 square miles in extent, containing 4 cantons, 20 communes, and a population of 18,304 persons. The capital is a market-town of the same name, on the river Ubaye, 3600 feet above the level of the sea, with 2130 inhabitants.

BARCELOR, a town of Asia, in the East Indies, on the coast of Malabar. It is supposed to be the ancient Barace, and has a considerable trade in pepper. Long. 74. 15. E. Lat. 13. 45. N.

BARCLAY, ALEXANDER, an English poet of considerable celebrity, appears to have been a native of Scotland. The place of his nativity has indeed been disputed; but Bishop Bale, in a work published during Barclay's lifetime, mentions him as a Scotsman;¹ and, according to Dr Bulleyn, another contemporary writer, he "was born beyond the cold river of Tweed." Holinshed likewise describes him as a Scot. On the other hand, Dr Pitts, who wrote at a more recent period, avers that he was an Englishman, and that his native district was probably Devonshire; but this averment is apparently founded on the mere circumstance of his having obtained preferment in that county.² Wood, adopting a similar opinion, designates him Alexander *de* Barklay, and suggests that he seems to have been born at or near a town so called in Somersetshire.³ It is however to be remarked that the poet's name is altered to suit this hypothesis, and that there is no such town or village in the county of Somerset. Berkeley is the name of a place in the county of Gloucester, but Berkeley and Barclay are not the same; and we adhere to the opinion of Ritson, that "both his name of baptism and the orthography of his surname seem to prove that he was of Scottish extraction."⁴ Certain however it is that he spent most of his life in England. He is said to have been partly educated in the university of Oxford, and is conjectured to have belonged to Oriel College; but this account is apparently to be received with some degree of caution, and may rest on no better foundation than the fact of his having dedicated his *Ship of Fools* to Dr Cornish, provost of that college, and suffragan bishop of Tyne in the diocese of Bath. He describes himself as the bishop's humble chaplain, but this may perhaps be considered as merely a courteous form of speech; for in the poem itself, he represents himself as the "chaplayne and bedeman" of "my master Kyrkham." Barclay appears to have taken the degree of doctor of divinity. On one occasion he makes an allusion to what he had observed at Cambridge. It may be considered as highly probable that he completed his studies in one of those universities, and that the connexions which he thus had an opportunity of forming, induced him to fix his residence in the south; and when we suppose him to have enjoyed the benefit of an English education, it need not appear peculiarly "strange that in those days a Scot should obtain so great reputation in England."⁵ From his first eclogue, we learn that he spent some of his earlier days at Croydon in Surrey; and in the year 1508 we find him a prebendary of the collegiate church of St Mary Ottery

Barcelo-
nette
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Barclay.

¹ "Alexander Barkeley, Scotus, rhetor ac poeta insignis." (*Balei Illustrium Majoris Britanniae Scriptorum Summarium*, f. 254. b. Gippeswici, 1548, 4to.) In a more recent publication, he mentions Barclay as a person, "quem alii Scotum, alii Anglum fuisse contendunt." (*Scriptorum illustrium Majoris Britanniae Catalogus*, p. 723. Basilæ, 1559, fol.)

² "Quibusdam Scotus fuisse videtur, sed Anglus vero fuit, patria, ut probabile est, Devonienensis. Nam ibi ad S. Mariam de Otery presbyter primum fuit." (*Pitæus De illustribus Angliæ Scriptoribus*, p. 745. Paris. 1619, 4to.)

³ Wood's *Athenæ Oxonienses*, vol. i. col. 205.

⁴ Ritson's *Bibliographia Poetica*, p. 46.

⁵ *Biographia Britannica*, vol. i. p. 586.

Barclay. in Devonshire. He afterwards became a Benedictine monk of the monastery of Ely, and at length assumed the habit of St Francis at Canterbury. Having survived the dissolution of the monasteries, he became successively vicar of Much-Badew in Essex, and, in 1546, of Wokey in Somersetshire; and was finally presented by the dean and chapter of Canterbury to the rectory of All-Saints in Lombard-street. As he retained some of his preferments in the reign of Edward VI., it is presumed that he must have complied with the changes of the times. Having reached a very advanced age, he died in the year 1552, and was interred at Croydon.

Barclay wrote at a period when the standard of English poetry was extremely low; and, as excellence is always comparative, this circumstance may partly enable us to account for the high reputation which he enjoyed among his contemporaries. If not entitled to the name of a poet, he is at least a copious versifier. His most conspicuous performance is the *Ship of Fools*, first printed by Pinson in the year 1509. The original design, and many of the details, were derived from Sebastian Brandt,¹ a civilian of Strasburg, who in 1494 published a poem entitled *Das Narren Schyff*,² which was so well adapted to the taste of the age that a Latin and a French version appeared in 1497, and another French version in 1498. Barclay professes to have translated "oute of Laten, Frenche, and Doche;" but to the original cargo he has added many fools of English growth. Under the representation of a ship freighted with fools of various denominations, the poet exposes the prevalent vices and follies of the age; and although, as Warton remarks, the poem is destitute of plot, and the voyage of adventures,³ the general design was found to possess many attractions. Another publication of Barclay is the *Mirrour of good Manners*, translated from the poem of Mancini *De quatuor Virtutibus*. His *Eglogues* chiefly excite curiosity as the earliest specimen of pastoral poetry in the English language, but their other attractions are not very powerful. They are of a more recent date than Henryson's *Robene and Makyne*, and are certainly very inferior in poetical merit. Among his prose works we find a version of Sallust's history of the war with Jugurtha: it was twice printed by Pinson, and is an early specimen of an English translation from the classics. (x.)

BARCLAY, William, M. D. was the brother of Sir Patrick Barclay of Tolly,⁴ and was likewise related to his learned namesake mentioned in the next article. This latter fact is ascertained by the hendecasyllables subjoined to his notes on Tacitus, and bearing the subsequent inscription: "Nobili et clarissimo viro Guil. Barclayo cognato meo, pro explicato Taciti Agricola, Joannes Barclayus Guil. F. scripsi." The writer of these verses, we may remark, must then have been only seventeen years of age. Barclay prosecuted his studies in the university of Louvain under Justus Lipsius, a great master of Roman

literature; and to him this distinguished professor has addressed two of his printed letters.⁵ He describes himself as A. M. and M. D.; but where he took those degrees we are not informed. Having been appointed a professor in the university of Paris, he there taught humanity for several years, and acquired a considerable share of reputation by his talents and learning. He afterwards visited his native country, where he appears to have followed the medical profession; but it may be inferred from Dempster's brief notice, that, in consequence of his adherence to popery, his situation was rendered uncomfortable by the clergy, and having returned to France, he resumed his former occupation at Nantes in Bretagne.⁶ The same literary historian mentions, that, at the period of his writing, Barclay was residing in Scotland, and, according to his information, was pursuing the practice of physic.

The following is a list of all the publications of Dr Barclay with which we are acquainted.

1. Guilielmi Barclayi Oratio pro Eloquentia. Ad v. cl. Ludovicum Servinum, Sacri Consistorii Regii Consiliarium, et in amplissimo Senatu Parisiensi Regis Advocatum. Paris. 1598, 8vo.

2. C. Cornelii Taciti Opera quæ exstant, ad exemplar quod J. Lipsius quintum recensuit. Seorsim excusi commentarii ejusdem Lipsii meliores plenioresque cum curis secundis, et auctariolo non ante adjecto. Guil. Barclayus Præmetia quædam ex Vita Agricola libavit. Adjecti sunt indices aliquanto ditiores. Paris. 1599, 8vo.—Menage, in his *Remarques sur la Vie de Pierre Ayrault*, p. 230, has ascribed these *Præmetia* to the civilian, and the same error has been committed by other writers.

3. Nepenthes, or the Vertues of Tabacco. By William Barclay, Mr of Art, and Doctor of Physicke. Edinb. 1614, 8vo.—This tract is dedicated to the author's nephew, Patrick the son and heir of Sir Patrick Barclay of Tolly; and the dedication is preceded by "A merie Epistle of the Author to the Printer," who is no other than "good Master Hart." To this worthy friend he makes the following communication: "If I find fauour in this essay, I shal send you shortly, Godwilling, a scholasticall subiect, and a curious litle worke, fit onely for those which aspire to the top of Pindus. The one wil bring to your shop the common sort of people, the other the most learned." At the end of the tract he has inserted six little poems, the first of which is addressed to Alexander Craig.

4. Guil. Barclayi, Amœnorum Artium, et Medicinæ Doctoris, Judicium de Certamine G. Eglisemmii cum G. Buchanano, pro Dignitate Paraphraseos Psalmi ciiii. Non violandi Manes. Adjecta sunt, Eglisemmii ipsum Judicium, ut editum fuit Londini, typis Eduardi Aldæi, an. Dom. 1619; et, in gratiam studiosæ juventutis, ejusdem Psalmi elegans paraphrasis Thomæ Rhædi. Lond. 1620, 8vo.—Dr Eglisam, like a fair as well as a bold critic, exhibited his own verses in competition with those of Buchanan,

¹ Sebastian Brandt, doctor of laws, was born at Strasburg about the year 1458. He studied in the university of Basel; and after having publicly taught there, as well as in his native city, he became syndic of Strasburg, where he died in the year 1520. (Adami Vitæ Germanorum Jureconsultorum et Politicorum, p. 5. edit. Francof. ad Moen. 1706, fol.) He is extolled by his contemporary Trithemius as "utriusque juris professor insignis, et tam in divinis Scripturis, quam aliis sæcularis literaturæ disciplinis egregie doctus, poeticam non mediocriter callens, ingenio subtilis, eloquio disertus, consilio ac actione præcipuus." (De Scriptoribus Ecclesiasticis, f. ccii. a. edit. Paris. 1512, 4to.) His writings embrace a considerable variety of subjects. We have a copy of one of his professional works, entitled *Titulorum omnium Juris tam Civilis quam Canonici Expositiones*. Lugduni, 1608, 8vo.

² See Dr Ebert's *Allgemeines bibliographisches Lexikon*, Band i. S. 230.

³ Warton's *Hist. of English Poetry*, vol. iii. p. 74.

⁴ Dr Barclay has himself mentioned the place of his birth. "Nam Collonia (sic castrum vocatur in quo primum terram tetigi) sita est in littore quod 'tam vasto atque aperto mari pulsatur.' Quo loco, ut obiter dicam, non pauca sunt vestigia veterum bellorum, cum Anglis præsertim. Est in eodem littore, in territorio gentis Barclayanæ, portus quidam, qui nostra lingua *Auld-heaven* appellatur." (*Præmetia*, p. 561.)

⁵ Lipsii *Epist. select.* cent. iii. ep. xxxiii. *Epist. cent. ad Germanos et Gallos*, ep. lvi.

⁶ "Inde in Scotiam profectus aliquantisper substitit, donec ministri illi Sathanæ magna eum molestia afficientes solum vertere coegerunt, qui in Galliis iterum docere bonas artes sustinuit Nanneti in Britannia Minore." (Dempster. *Hist. Ecclesiast. Gentis Scottorum*, p. 120.)

Barclay. and had no reason to congratulate himself on the issue. He was likewise assailed by another learned physician, Arthur Johnston, who, in two sarcastic and elegant poems, treated his case as one of decided insanity.

5. Guil. Barclaii, M. D. *Poemata. Delitiæ Poetarum Scotorum*, tom. i. p. 137.—These poems only occupy four pages and a half. (x.)

BARCLAY, William, LL. D. a distinguished civilian, was born in Aberdeenshire in the year 1541. He spent the early part of his life, and much of his fortune, at the court of Mary queen of Scots, from whose favour he had reason to expect preferment. In 1573 he went over to France, and at Bourges commenced student of the civil law under the famous Cujacius. He continued some years in that seminary, where he took his doctor's degree; and was soon after appointed professor of the civil law in the university of Pontamousson, recently founded by the duke of Lorraine. That prince afterwards made him counselor of state and master of requests. In the year 1581 Barclay married Anne de Malleville, a French lady, by whom he had a son, who became a celebrated author, and of whom the reader will find an account in the next article. This youth the Jesuits would gladly have received into their society; but his father refused his consent, and for that reason these disciples of Jesus soon contrived to ruin him with the duke his patron. Barclay now embarked for Britain, where King James offered him a considerable preferment, provided he would become a member of the church of England; but not chusing to comply with this condition, he returned to France in 1604, and, soon after his arrival, was appointed first professor of the civil law in the university of Angers, where he died the year following, and was buried in the Franciscan church.

Barclay was a man of superior talents, and still maintains a conspicuous place among civilians.¹ In his political opinions he was directly opposed to his illustrious countryman Buchanan, and was a strenuous defender of the rights of kings: his own speculations on the principles of government are best known to some readers from an incidental confutation by Locke, in his *Treatises on Government*. A list of his publications shall close this very brief notice.

1. De Regno et Regali Potestate, adversus Buchananum, Brutum, Boucherium, et reliquos Monarchomachos, libri sex. Paris. 1600, 4to.—This volume contains, or ought to contain, a portrait of the author, which however has in many instances been transferred to the portfolio of some collector.

2. In Titulum Pandectarum de Rebus creditis et Jurjurando Commentarii. Paris. 1605, 8vo.—This commentary is reprinted in Otto's *Thesaurus Juris Romani*, tom. iii.

3. De Potestate Papæ; an et quatenus in Reges et Principes seculares jus et imperium habeat: Liber posthumus. Mussiponti, 1610, 8vo.—This work may likewise be found in Goldasti *Monarchia*, tom. iii. p. 621. It was translated into French; and an English version is printed with the treatise of Sheldon, *Of the Lawfulness of the Oath of Allegiance*. Lond. 1611, 4to. Barclay's two treatises, *De Regno* and *De Potestate Papæ*, have repeatedly been

printed in the same volume. Hanoviæ 1612, 8vo. Hanoviæ, 1617, 8vo.

BARCLAY, John, son of the eminent civilian mentioned in the last article, was born at Pontamousson on the 28th of January 1582. He was there educated in the College of the Jesuits, and excited in his instructors so favourable an opinion of his capacity, that they made an attempt to entice him into their order; an attempt which was indignantly resisted by his father. At the age of nineteen, he evinced his literary ambition by publishing annotations on the *Thebais* of Statius. In 1603, when his father resigned his professorship in disgust, the young and aspiring scholar accompanied him to London; and at the beginning of the following year he presented his *Kalendæ Januariae* as a poetical offering to King James, to whom he soon afterwards dedicated the first part of his work entitled *Euphormionis Lusini Satyricon*. Both the father and the son were willing to accept of employment, and no doubt they both expected preferment. But, as Lord Hailes has remarked, "William Barclay was conscientiously attached to the church of Rome, and his son professed the religion of his forefathers. In those days a pension bestowed upon a Scottish Papist would have been numbered among the national grievances; and the vulgar would not have distinguished between favour shown to genius or learning, and partiality for the opinions of the person favoured."² In the year 1604 they both returned to France, and Dr Barclay was again placed in a situation suited to his talents and learning, having been appointed first professor of the civil law in the university of Angers. His taste for external magnificence appears to have been somewhat prominent: when he went to read his lecture, he was dressed in a superb gown, with a massy chain of gold about his neck, and was followed by his son and two valets.³

The younger Barclay, whose hopes of advancement had begun to revive, returned to England in 1605; but after a further residence of twelve months, he still found himself unsuccessful in his pursuit. His father died towards the close of the same year; and he afterwards removed to Paris, where he married Louise, the daughter of Michael Debonnaire, "Trésorier des Vieilles Bandes." He speedily fixed his abode in London, and there his wife bore him a son and two daughters, William, Anne, and Louise. M. de Peiresc, who was himself a man of learning, and was very extensively connected with the learned, found him in this metropolis in the year 1606, and their acquaintance was succeeded by an intimate friendship. During this year he published the second part of his *Satyricon*, which he dedicated to the earl of Salisbury; and likewise a brief narrative of the gunpowder plot, bearing the title of *Series patefacti divinitus Parricidii, in ter maximum Regem Regnumque Britannia cogitati et instructi*. In 1610 he published an apology for his *Satyricon*, which had excited so much resentment that he found it necessary to attempt some palliatives and explanations. A tract was published at Paris in 1620, under the title of *Censura Euphormionis*; and this was answered in a *Censura Censurae Euphormionis*, written by Pierre Musnier, canon of Vezelay.

¹ See Dr Browne's *Remarks on the Study of the Civil Law*, p. 25. Edinb. 1828, 8vo.

² Hailes's *Sketch of the Life of John Barclay*, p. 2. 4to edit.

³ Menage, *Remarques sur la Vie de Pierre Ayrault*, p. 230.

⁴ "On croit, pour le marquer icy en passant, que Séton, Ecossois, est l'auteur de ce petit livre." (Menage, p. 233.) The writer apparently alludes to Dr Seaton, a learned civilian, whom Tomasini enumerates among the eminent scholars of the age. (*Parnassus Eugeaneus, sive de Scriptoribus ac Literatis hujus Ævi claris*, p. 8. Patavii, 1647, 4to.) Balzac celebrated him in his Latin verses; Scioppius addressed the second epistle of his *Paradoxa Literaria* "Guilhelmo Setonio Scoto Jurisconsulto;" and his name is mentioned with much respect by various other writers of the same period. He is highly extolled in Sir Thomas Urquhart's *Discovery of a most exquisite Jewel*, p. 177. Lond. 1652, 8vo.

Barclay.

During the same year, 1610, he published an able work of his father, *De Potestate Papæ*, to which he prefixed a preface of nine pages, concluding with a clear intimation of his purpose to defend his father's memory against any unseemly attack. "Quod si aliquis hoc opus refellere instituet, velim ne oratoria fraude tantum leviam quædam carpat, in quibus nec ipse author multum subsidii posuerit; sed ipsam vim rationum excutiat, diluendi aut asserendi vitia accuset. Si quis aliter faxit, sciat Guilielmi Barclaii cineres loqui posse." It was not the object of this treatise to controvert the spiritual supremacy of the pope, which the author was ready to admit in its most orthodox sense; but while he acknowledged his power and jurisdiction in things spiritual, he strenuously contended against his usurped power over sovereign princes in things temporal. The work, which is written with learning and ability, excited no small degree of attention; and it was soon attacked by Cardinal Bellarmine, one of the most formidable defenders of the doctrines of the church, and of the pretensions of its visible head. The son was anxious to evince that the ashes of his revered father were yet capable of speaking. He had not neglected to study the law under so excellent a preceptor; and as he was by no means diffident of his own abilities, he did not shrink from a contest with so redoubtable an antagonist. He accordingly published a large volume bearing the title of *Joannis Barclaii Pietas; sive publicæ pro Regibus ac Principibus, ac privatæ pro Guilielmo Barclaii Parente Vindiciæ, adversus Roberti S. R. E. Cardinalis Bellarmini Tractatum de Potestate Summi Pontificis in Rebus Temporalibus*. Parisiis, 1612, 4to. To this work the cardinal did not himself reply, but an answer was speedily published under the name of *Andreae Eudæmon-Johannis Epistola monitoria ad Joannem Barclaium de Libro ab eo pro Patre suo contra Robertum Bellarminum S. R. E. Cardinalem scripto*. Col. Agrip. 1613, 8vo.

In 1614 Barclay published at London his *Icon Animorum*, which forms the fourth part of his *Satyricon*. This work is written with talent and vivacity, and may still be perused with pleasure. It is, as Lord Hailes has correctly stated, a delineation of the genius and manners of the European nations, with remarks, moral and philosophical, on the various tempers of men. For the land of his forefathers the author has not failed to testify a sufficient degree of affection. He duly extols the antiquity of the royal line, "inclyto sceptro supra fidem et ætatem regnorum cæterorum." Nor is the literary character of the people left without its share of commendation. "Animi illis in quæcunque studia inclinant, mirifico successu inclyti, ut nullis major patientia castrorum, vel audacia pugnae, et Musæ nunquam delicatius habeant quam cum inciderunt in Scotos."¹ Some of his sketches of the national character are happy and graphic.

After a residence of ten years in England, Barclay found himself without any sufficient inducement to prolong his stay. To some extent or other, he had experienced the bounty of the earl of Salisbury; and although it does not appear that he obtained any regular provision from the king, we may perhaps suppose that he at least received occasional gratuities; but his resources continued to be scanty, and his situation precarious. Towards the close of the year 1615 he proceeded to Paris, where he had the pleasure of meeting his friend M. de Peiresc, and the ho-

nour of being introduced by him to the keeper of the seals, Guillaume du Vair. Having been invited to Rome by Pope Paul V., he there fixed his residence in the beginning of the ensuing year, and by the publication of his next work he endeavoured to prove himself a worthy denizen of this pious city. The work to which we allude is entitled *Joannis Barclaii Parænesis ad Sectarios, libri ii.* Romæ, 1617, 8vo. "It is probable," says Lord Hailes, "that by this exhortation to the sectaries, he meant to give evidence of his own orthodoxy, and to atone for the liberties, almost heretical, which he had taken, as well with the papal court, as with its most faithful adherents. But that court, which had Cardinal Bellarmine for its champion, required not the feeble and suspicious aid of the author of Euphormion.—Although Barclay found much civility at Rome, yet it does not appear that he obtained any emolument. Incumbered with a wife and family, and having a spirit above his fortune, he was left at full leisure to pursue his literary studies. It was at that time that he composed his Latin romance called *Argenis*. He employed his vacant hours in the cultivating of a flower-garden. Rossi (or Erythræus) relates, in the turgid Italian style, that Barclay cared not for those bulbous roots which produce flowers of a sweet scent; and that he cultivated such as produced flowers void of smell, but having variety of colours. Hence we may conclude that he was amongst the first of those who were infected with that strange disease, a passion for tulips, which soon after overspread Europe, and is still remembered under the name of the *Tulipo-mania*. Barclay had it to that excess, that he placed two mastiffs as centinels on his garden; and, rather than abandon his favourite flowers, chose to continue his residence in an ill-aired and unwholesome habitation." The preceding account of his success at Rome is not reconcilable with that of Erythræus, who avers that from Cardinal Barberini he obtained riches as well as civility;² but as these benefits are said to have been conferred after the cardinal's elevation to the papal chair, the narrative is liable to some degree of suspicion. The election of Urban VIII. did not take place till the year 1623, and Barclay was then beyond the reach of preferment. It is not however probable that a writer of high reputation, who had been invited by the pope, and was caressed by cardinals, was left without some substantial mark of favour. Bellarmine, whom he had formerly undertaken to refute, was so far from cherishing any resentment, that he honoured him with various marks of kindness.

Barclay died at Rome on the twelfth of August 1621, in the fortieth year of his age. The disease which proved fatal to him was the stone; a disease for which, in his *Satyricon*, he had pronounced the plant called golden rod to be a specific remedy. His remains were interred in the church of S. Onufrio; and at the church of S. Lorenzo, on the road to Tivoli, his widow erected for him a monument, with his bust in marble; but on learning that Cardinal Francesco Barberini had there erected a similar monument in honour of his preceptor, she indignantly caused the bust to be removed. The inscription on Barclay's monument was soon erased; but by whom, or for what reason, is not very clearly ascertained. There is however no improbability in the reason assigned by Freherus, who imputes this act to the vindictive feelings of the Jesuits, an order of men very frequently subjected to his satire.³

Barclay.

¹ *Joannis Barclaii Icon Animorum*, p. 92. Lond. 1614, 8vo.

² "Qui deinde, ad Deo proximum, in terris, dignitatis locum evectus, Urbani VIII. nomine, non modicæ illi utilitati et commodo fuit; nam et divitias et opes ac gratiam contulit, filiumque ejus majorem natu et pingui sacerdotio locupletavit, et honorarii intimi cubicularii titulo cohonestavit." (Erythræi *Pinacotheca*, tom. iii. p. 79.) See likewise *Imperialis Musæum Historicum*, p. 170.

³ Freheri *Theatrum Virorum Eruditione clarorum*, tom. ii. p. 1515.—"Inscriptionem ac statuam," says an earlier writer, "cautiore patres consilio sublatam ac deletam voluerunt." (*Imperialis Musæum Historicum*, p. 171. Venet. 1640, 4to.)

Barclay. At the time of his death, the romance of *Argenis* was printing under the superintendence of Peiresc,¹ and was soon afterwards given to the public. Paris. 1621, 8vo. Besides a son and two daughters born in England, Barclay had a son who was born at Rome. His elder son is represented by Erythræus as having obtained a rich benefice from Urban VIII. With one of his sons Menage was acquainted at Paris in the year 1652; and, in his opinion, "ce n'estoit pas un grand personnage." Like his father, he was a writer of Latin verses, and at this period he there printed an elegy. We are not aware that the descendants of Barclay are at present to be traced either in France or Italy.

This ingenious writer, who was thus arrested in the middle of his literary career, left an unpublished history of the conquest of Jerusalem by the Franks, and some fragments of a general history of Europe. Erythræus informs us that he had himself transcribed a manuscript tract of his, relating to the defection of M. Ant. de Dominis, archbishop of Spalato; and that from his knowledge of the national character, as well as of the disposition of the king, the author foretold that he could not long remain in England.

The ambition of Barclay was greater than his fortune; nor did his propensity to satirize one class of individuals prevent him from offering abject flatteries to another. But at that period few men of letters knew how to blend self-respect with a proper deference to their superiors in the artificial scale of society. His personal character, with an ample allowance for his vanity as an author, appears to have been respectable. "Some very indecent descriptions in Euphormion," as Lord Hailes has remarked, "lead us to form an unfavourable conjecture as to the manners of Barclay. There is however no proof that he was a loose man; and indeed it is probable that he wrote loosely because Petronius, whom he had chosen for his model in satire, affected that style. Barclay entered into the married state at a very early period of life; and he appears to have continued the fond husband of his *Aloysia*.... There is a presumption, at least, that he who was a good son and a good husband, was also a virtuous man in other respects; and if there had been any remarkable blemish in the morals of Barclay, some of his numerous and virulent adversaries would have pointed it out." He appears to have been subjected to considerable annoyance in consequence of the jealousy of his wife; but in many cases jealousy is a wayward passion, and proceeds from the mere excess of affection, as well as from the knowledge or suspicion of specific and painful facts.

Barclay was evidently a man of genius, and with a vigorous imagination he united a competent share of learning. His literary efforts were sufficiently variegated; quitting the regions of poetry and romance, he ventured to discuss subjects of jurisprudence and theology. His Latin poems exhibit marks of fancy and ingenuity, nor is his skill as a versifier less conspicuous.² The *Satyricon* is formed on the model of Petronius, and includes occasional verses interspersed with the prose. The talent displayed in this work would alone have been sufficient to secure him a high reputation among the writers of the age; but the fame of all his other productions has in a great measure been eclipsed by that of his *Argenis*, which,

after the lapse of two centuries, still finds readers and admirers. "*Argenis*," says Lord Hailes, "is generally supposed to be a history under feigned names, and not a romance. Barclay himself contributed to establish this opinion, by introducing some real characters into the work. But that was merely to compliment certain dignitaries of the church, whose good offices he courted, or whose power he dreaded. The key prefixed to *Argenis* has perpetuated the error. There are no doubt many incidents in it that allude to the state of France during the civil wars in the seventeenth century; but it requires a strong imagination indeed to discover Queen Elizabeth in Hyannisbe, or Henry III. of France in Meleander. On the whole, *Argenis* appears to be a poetical fable, replete with moral and political reflections." This is a sober and correct account of the work; but Cowper has expressed his approbation in more glowing terms. "The work I mean is Barclay's *Argenis*; and, if ever you allow yourself to read for mere amusement, I can recommend it to you (provided you have not already perused it) as the most amusing romance that ever was written. It is the only one indeed of an old date that I ever had the patience to go through with. It is interesting in a high degree, richer in incident than can be imagined, full of surprises, which the reader never forestalls, and yet free from all entanglement and confusion. The style too appears to me to be such as would not dishonour Tacitus himself." In another letter he expresses himself thus:—"I have also read Barclay's *Argenis*, a Latin romance, and the best romance that was ever written."³ This romance was a special favourite with Cardinal Richelieu, and also with Leibnitz, a much greater man than the cardinal.

Cowper appears to have been struck with the point and vivacity of his style, which indeed are sufficiently distinguishable; but for the purity of his Latin diction Barclay is not entitled to equal commendation. Being probably impelled by the rapid current of his fancy, he adopts a variety of words and idioms which well express his meaning, but which nevertheless do not belong to the best ages of Latinity. The distich of Grotius, engraved under Barclay's portrait, seems therefore to contain a compliment which must not be too literally interpreted:

Gente Caledonius, Gallus natalibus, hic est
Romam Romano qui docet ore loqui.

Joseph Scaliger, whose literary judgments were frequently severe, and not unfrequently capricious, mentions Barclay's *Satyricon* in terms of great disparagement; but whether his censure is chiefly directed against the Latinity or against the general strain of the work, is not altogether certain.⁴ This book, whatever may be its demerits, has passed through many editions, and has been translated into the French and German languages.⁵ It has likewise had the advantage of being illustrated with notes. Lugd. Bat. 1674, 8vo. The fourth part, the *Icon Animorum*, has repeatedly been printed in a separate form. One edition bears this inscription: "Joannis Barclaii Icon Animorum, celeberrimi viri Augusti Buchneri notis, adjecto rerum indice, illustrata." Dresdæ, 1680, 8vo. The book soon appeared in an English dress: "The Mirror of Minds, or Barclay's *Icon Animorum*; Englished by Tho. May, Esq." Lond. 1633, 12mo. Of this translation there is another edition in the same form; but the only copy

¹ Gassendi *Vita Nicolai Claudii Fabricii de Peiresc*, p. 176. Paris. 1641, 4to.

² Joannis Barclaii *Poematum libri duo*. Lond. 1615, 4to. Oxon. 1636, 12mo.—His poems may likewise be found in the *Delitiae Poetarum Scotorum*, tom. i. p. 76. "Sed quid Joanne Barclaii Scoto, etiam in hoc genere Musarum, exactius, numerosius, et quantoque sublimius?" (Borrichii *Dissertationes academicæ de Poetis*, p. 149. Francof. 1683, 4to.)

³ Hayley's *Life of Cowper*, vol. i. p. 243, 247. 4to edit.

⁴ "Quanti Euphormionem Barclaii faciam, ex eo cognoscere potes, quod vix sex folia ejus legere potuerim." (Jos. Scaligeri *Epistolæ*, p. 657. Lugd. Bat. 1627, 8vo.) See Colomesii *Opuscula*, p. 157, and Menage's *Remarques sur la Vie de Pierre Ayrault*, p. 233.

⁵ *Biographie Universelle*, tom. iii. p. 360. Ebert's *Allgemeines bibliographisches Lexikon*, Band i. S. 137.

Barclay. to which we have access contains a mutilated title, and we therefore cannot discover the date. Two French versions had appeared in the course of one year. "Le Pourtrait des Esprits de Jean Barclai, mis en François." Paris, 1625, 12mo. "Le Tableau des Esprits de M. Jean Barclay: par lequel on cognoist les humeurs des Nations, leurs avantages et defaux, les inclinations des hommes, tant à cause de leurs propres naturels que des conditions de leurs charges. Nouvellement traduit de Latin en François." Paris, 1625, 8vo. The dedication of the duodecimo is subscribed Nantevil de Boham; and he has taken such liberties with the original, that his work can scarcely claim the name of a translation. There is a German translation of a very recent date: "Johann Barklai's Gemälde der menschlichen Charaktere nach Verschiedenheit der Alter, Zeiten, Länder, Individuen und Stände: aus dem Lateinischen übersetzt, und mit Anmerkungen und geschichtlichen Nachweisungen begleitet, von Anton Weddige, Pastor zu Lippborg." Münster, 1821, 8vo. A continuation of the *Satyricon* had been published by Claude Morisot, under the title of *Alitophili Veritatis Lachrymæ*; and Lord Hailes describes it as a masterpiece of absurdity.

The editions and versions of the *Argenis* are much more numerous. An edition with notes appeared under the title of "Joannis Barclaii Argenis, nunc primum illustrata." Lugd. Bat. et Roter. 1664, 8vo. This was followed in 1669 by a uniform edition of the continuation: "Archombrotus et Theopompus, sive Argenidis secunda et tertia pars, ubi de Institutione Principis." The notes, which are not held in much estimation, were written by Bugnot, a Benedictine who taught rhetoric in the abbey of Tiron. Lord Hailes mentions a French translation published at Paris, 1622, 8vo; and another with the subsequent title now lies before us: "L'Argenis de Jean Barclay: traduction nouvelle, enrichie de figures." Paris, 1625, 8vo. There are other two French versions of a more recent date, one by the Abbé Josse, a canon of Chartres, 1732, 3 tom. 12mo; and another by M. Savin, Paris, 1776, 2 tom. 8vo. Barclay's romance soon appeared in Spanish; and a copy of this rare version belongs to the Astorga collection in the Advocates Library: "Argenis, por Don Joseph Pellicer de Salas y Tobar. A Don Antonio de Negro, Noble de la Serenissima Republica de Genova." Madrid, 1626, 4to. Don Joseph has somewhat unfairly excluded Barclay's name from the title-page. An English version was speedily published by Sir Robert Le Grys and Thomas May, Esq. Lond. 1628, 4to. And another was executed by Kingsmill Long, Esq. Lond. 1636, 4to. After a long interval appeared "The Phoenix, or, the History of Polyarchus and Argenis. By a Lady." London, 1772, 4 vols. 12mo. The preface of this publication states that "the editor has made use of both the former translations occasionally, and, whenever a doubt arose, had recourse to the original." Lord Hailes has judiciously enough suggested that "the lady would have done as well had she made use of the original, and only consulted the translations when any doubt arose." The *Argenis* was at an early period translated into German: "Joan. Barclai Argenis, verdeutscht durch Martin Opitz." Amsterdam, 1644, 12mo. In this country, the version of Opitz is extremely rare; and the only copy that has fallen under our inspection belongs to the writer of the present notice. Another German translation was published by J. Ch. L. Haken. Berlin, 1794, 2 Bde. 8vo. An Italian version was executed by Francesco Pona; and this celebrated romance

has even been translated into the Polish, Swedish, and Islandic languages. Among the northern manuscripts in the Advocates Library there is a *Saga af Argenide*, translated in the year 1694 by a schoolmaster named Einarson.¹

BARCLAY, Robert, one of the most eminent among the Quakers, the son of Colonel David Barclay, was born at Edinburgh in 1648. He was educated under an uncle at Paris, where the Papists used all their efforts to draw him over to their religion. But he joined the Quakers in 1669, and distinguished himself by his zeal and abilities in defence of their doctrines. In 1676 he published, in Latin, at Amsterdam, his *Apology for the Quakers*, which is the most celebrated of his works, and esteemed the standard of the doctrine of the Quakers. The *Theses Theologicae*, which were the foundation of this work, and addressed to the clergy generally, were published before the *Apology*, and printed in Latin, French, German, Dutch, and English. The dedication of his *Apology* to king Charles II., is very remarkable for the uncommon frankness and simplicity with which it is written. Amongst many other extraordinary passages, we meet with the following: "There is no king in the world who can so experimentally testify of God's providence and goodness; neither is there any who rules so many free people, so many true Christians; which thing renders thy government more honourable, thyself more considerable, than the accession of many nations filled with slavish and superstitious souls. Thou hast tasted of prosperity and adversity; thou knowest what it is to be banished thy native country, to be over-ruled as well as to rule and sit upon the throne; and being oppressed, thou hast reason to know how hateful the oppressor is both to God and man; if, after all those warnings and advertisements, thou dost not turn unto the Lord with all thy heart, but forget him who remembered thee in thy distress, and give thyself up to follow lust and vanity, surely great will be thy condemnation." He travelled with the famous William Penn through the greater part of England, Holland, and Germany, and was everywhere received with the highest respect; for though both his conversation and behaviour were suitable to his principles, yet there was such liveliness and spirit in his discourse, and such serenity and cheerfulness in his deportment, as rendered him extremely agreeable to all sorts of people. When he returned to his native country, he spent the remainder of his life in a quiet and retired manner. He died at his own house at Ury, on the 3d of October 1690, in the 42d year of his age.

BARCLAY, JOHN, M.D. a distinguished anatomist, was born in Perthshire in 1760, and died at Edinburgh in 1826. After the usual routine of parochial education, Dr Barclay was entered as a student at the United College of St Andrews, where he distinguished himself as a classical scholar. He subsequently studied divinity in the same university, and was licensed as a preacher by the presbytery of Dunkeld. Having repaired to Edinburgh in 1789, as tutor to the family of Sir James Campbell of Aberuchill, Dr Barclay began to give his attention to the study of medicine, and particularly to anatomy, both human and comparative. He became assistant to the late Mr John Bell, and took the degree of doctor of physic in the university of Edinburgh in 1796, after having defended an inaugural dissertation, *De Anima, seu Principio Vitali*. This subject seems very early to have engaged his attention; and his last work, on *Life and Organization*, in which his views are more fully developed, affords a proof of the continued

¹ This translator of Barclay was "Joh. Einari, scholæ primum Skalholtinæ hypodidasculus, deinde rector scholæ Holensis designatus." (Halldani Einari *Sciagraphia Historiæ Literariæ Islandicæ*, p. 66. Havnæ, 1777, 8vo.) He appears to have been a writer of verse as well as prose.

Barclay. assiduity with which Dr Barclay prosecuted his inquiries in this interesting field of research.

Immediately after his graduation, having determined, it is believed somewhat suddenly, to come forward as a teacher of anatomy, he repaired to London, and studied for some time under the late Dr Marshall of Thavies Inn, at that time a very distinguished teacher of anatomy in the metropolis.

Soon after his return from London, Dr Barclay commenced his lectures on anatomy in Edinburgh in November 1797; and by his punctual attention to his engagements, and assiduous devotion to the instruction of his pupils, he speedily attracted a respectable audience, which continued gradually to increase in numbers until the period of his retirement, a short time before his death.

Of Dr Barclay's professional writings, the earliest, we believe, was the article *PHYSIOLOGY*, which he furnished for the third edition of this work.

In 1803, six years after he commenced his career as a teacher, Dr Barclay attempted a reform in the language of anatomy, with a view to render it more accurate and precise; a task for which his acquirements as a classical scholar rendered him peculiarly fit. Although the *Nomenclature* which he published upon that occasion has not yet been generally adopted, we believe that the profession, with one voice, acknowledges the importance of the object which he had in view, and the talent and learning with which it was executed. Some of his illustrations of the defects in the existing language of anatomy, particularly in the terms expressive of position and aspect, were peculiarly striking, and highly characteristic of his overflowing humour. "The terms *above*, *below*, *behind*, and *before*," he used to observe, "would be sufficiently definite if the body were uniformly to preserve the same position; and so," said he, "would be the expression in *Hudibras*, where the author makes Crowdero apply a squeaking-engine to the *north-east* side of his neck: this would be sufficiently definite if one could ascertain, by compass, in what particular position the fiddler stood."

His next work, published in 1808, was a *Treatise on the Muscular Motions of the Human Body*, calculated to encourage a more attentive study of the simple and combined actions of the muscles, with a view to a more scientific and successful treatment of fractures and luxations; a department of surgery which, even now, although illustrated by his distinguished friend Sir Astley Cooper, can scarcely be said to be rescued from those popular prejudices under which it has so long laboured.

In 1812 Dr Barclay published the first edition of his *Description of the Arteries of the Human Body*; a work displaying much acute observation and laborious research, and which may perhaps be considered the most practically useful of all his writings. The labour which this work must have cost him may be judged of by the fact, that he wrote no description of any artery until he had studied its delineation, as given by Haller, and every other standard authority, and until he had actually examined its course and distribution in every preparation to which he had access; in some instances repairing to Glasgow to examine the excellent collection of vascular preparations then in the possession of his friend Mr Allan Burns.

His last publication, completed only a few years before his death, was *An Inquiry into the Opinions, Ancient and Modern, concerning Life and Organization*; a work replete with learning and original criticism, and well calculated to check the progress of those idle and dangerous speculations by which some of our modern philosophers have been distinguished. This, like all his former publications, is dedicated to Dr Thomas Thomson, professor of chemis-

try in the university of Glasgow, one of the earliest and most distinguished of his numerous friends.

These several works, which afford such remarkable proofs of the inexhaustible energies of Dr Barclay's mind, were undertaken and completed amidst the incessant and laborious toils which his courses of anatomical lectures necessarily imposed upon him. Of these he gave two very full ones every winter, commencing each of them early in November, and terminating at the end of April. For several years previous to his death he had also given a course of comparative anatomy during the summer months. To this branch of study Dr Barclay had always shown a marked partiality, not only as an object of scientific research, but of great practical utility. He pressed upon the Highland Society of Scotland, of which he was a distinguished member, the propriety of giving encouragement to the study of veterinary medicine; and to him, in conjunction with his friend Mr Robert Johnston, the public is chiefly indebted for the establishment of the veterinary school, so successfully conducted by his pupil Mr Dick, under the auspices of the liberal and patriotic body above mentioned.

At the period of his death Dr Barclay was engaged in revising and preparing for the press his introductory lectures, which have since been published, and contain a valuable abridgement of the history of anatomy.

His successful progress as a teacher of anatomy Dr Barclay always gratefully attributed, in a great measure, to the patronage which, at an early period, he received from the Royal College of Surgeons of Edinburgh; and to that learned and public-spirited body he bequeathed his anatomical collection, now known as the Barclayan Museum, which contains many valuable specimens in comparative anatomy, and some of the finest vascular preparations which are anywhere to be found. (Q. Q.)

BARCOCHEBAS, or rather BARCOCHAB, a Jewish impostor, whose real name was *Akiba*, but who took that of *Barcochab*, which signifies the *Son of a Star*, in allusion to the prophecy of Balaam, "There shall a star arise out of Jacob." He proclaimed himself the Messiah; and talking of nothing but wars, victories, and triumphs, made his countrymen rise against the Romans, by which means he became the author of innumerable disorders. He ravaged many places, took a great number of fortresses, and massacred an infinite multitude of people, particularly Christians. The emperor sent troops to Rufus, governor of Judæa, with orders to suppress the sedition; and Rufus, in obedience, exercised a thousand cruelties, but could not complete his task. The emperor was therefore obliged to send Julius Severus, the greatest general of that time, who attained his end without a direct battle; for he fell on the enemy separately, cutting off their provisions, and at last the whole contest was reduced to the siege of Bitter, in the eighteenth year of Hadrian. There the impostor perished. This war cost the Romans a great deal of blood.

BARD, a word denoting a poet by profession, who, to use the language of Ossian, "sung of the battles of heroes, or the heaving breasts of love."

Anciently bards were necessary persons at every festival and at every solemnity. Their songs, which, by recording the achievements of kings and heroes, animated the soul of the hearer, must have been the entertainment of every warlike nation. We have Hesiod's authority, that in his time bards were as common as potters or joiners, and as liable to envy. Cicero reports, that anciently at Roman festivals the virtues and exploits of their great men were celebrated in song. The same custom prevailed in Peru and Mexico, as we learn from Garcilasso and other authors. But in no part of the world did the profession of bard appear with such lustre as in Gaul, in Britain, and in Ire-

Barcoche-
bas
||
Bard.

Bardas. land. Wherever the Celtæ or Gauls are mentioned by ancient writers, we seldom fail to hear of their druids and their bards, the institution of which two orders was the capital distinction of their manners and policy. The druids were their philosophers and priests, the bards their poets and recorders of heroic actions; and both these orders of men seem to have subsisted among them as chief members of the state from time immemorial. The Celtæ possessed, from very remote ages, a regular system of discipline and manners, which appears to have had a deep and lasting influence. Ammianus Marcellinus expressly declares, that there flourished amongst them the study of the most laudable arts, introduced by the bards, whose office it was to sing in heroic verse the gallant actions of illustrious men; and by the druids, who lived together in colleges or societies, after the Pythagorean manner, philosophizing upon the highest subjects, and asserting the immortality of the human soul. Though Julius Cæsar, in his account of Gaul, does not expressly mention the bards, yet it is plain that, under the title of druids, he comprehends that whole college or order, of which the bards, who, it is probable, were the disciples of the druids, undoubtedly made a part. It deserves remark, that, according to his account, the druidical institution first took its rise in Britain, and passed from thence into Gaul; so that they who aspired to be thorough masters of that learning were wont to resort to Britain. He adds, too, that such as were to be initiated among the druids were obliged to commit to memory a great number of verses, insomuch that some employed twenty years in this course of education; and that they did not think it lawful to record these poems in writing, but handed them down by tradition from race to race.

So strong was the attachment of the Celtic nations to their poetry and their bards, that amidst all the changes of their government and manners, even long after the order of the druids had been extinct, and the national religion altered, the bards continued to flourish, not as a set of strolling songsters, like the Greek *αοιδοι* or *rhapsodists* in Homer's time, but as an order of men highly respected in the state, and supported by a public establishment. According to the testimonies of Strabo and Diodorus, they existed before the age of Augustus Cæsar; and we find them flourishing under that sovereign, and exercising the same functions as of old, in Ireland and in the north of Scotland, almost down to our own times. It is well known that, in both these countries, every *regulus* or chief had his own bard, who was considered an officer of rank and consequence in his little court.

The bards, as well as the druids, were exempted from taxes and military services, even in times of the greatest danger; and when they attended their patrons in the field to record and celebrate their great actions, they had a guard assigned them for their protection. At all festivals and public assemblies they were seated near the person of the king or chieftain, and sometimes even above the greatest nobility and chief officers of the court. Nor was the profession of the bards less lucrative than it was honourable. For, besides the valuable presents which they occasionally received from their patrons when they gave them uncommon pleasure by their performances, they had estates in land allotted for their support. Nay, so great was the veneration which the princes of these times entertained for the persons of their poets, and so highly were they charmed and delighted with their tuneful strains, that they sometimes pardoned even their capital crimes for a song.

BARDAS, the brother of the empress Theodora, and uncle of the famous Photius, is said to have had no good quality besides that of loving the sciences and polite litera-

ture, which he established in the eastern empire; for otherwise he was treacherous, cruel, and ambitious. In the year 856 he assassinated Theoctistes, general of the emperor Michael's forces, and obtained his post. At length he caused the disgrace of the empress Theodora; and St Ignatius, patriarch of Constantinople, reproaching him for his vices, he had the prelate deposed, in 858, in order to make room for Photius. Bardas was assassinated by Basilus the Macedonian in 866.

BARDESANISTS, a sect of ancient heretics, thus denominated from their leader Bardesanes, a Syrian of Edessa, in Mesopotamia. Bardesanes, born in the middle of the second century, became eminent, after his conversion to Christianity, for his zeal against heretics, and wrote a multitude of books against them; yet had he the misfortune to fall himself into the errors of Valentinus, to which he added some others of his own. He taught that the actions of men depend altogether on fate, and that God himself is subject to necessity. His followers went further, and denied the resurrection of the body, as well as the incarnation and death of our Saviour, holding that these were only apparent or fantastical.

BARDEWICK, a town of Germany, in the circle of Lower Saxony and duchy of Lunenburg, formerly a very large place, but being ruined in 1189 by the duke of Saxony, it never afterwards recovered its former consequence. It is seated on the river Ilmenau, in long. 10. 6. E. lat. 53. 40. N.

BARDOE, the most northern inhabited place in Europe, in the province of East Finmark, in Norway. It has a small harbour, closed by ice during the greater part of the year. It contains only 100 inhabitants, who have a fort to defend their little storehouses. Long. 31. 1. 25. E. Lat. 70. 22. 35. N.

BARDT, a strong and rich town of Germany, in the duchy of Pomerania, with a castle and a spacious harbour. It is subject to the Swedes; and is situated near the Baltic Sea, in long. 13. 20. E. lat. 54. 23. N.

BAREILLY, a large and populous city of Hindostan, in the province of Delhi, and capital of the district of Bareilly, and of Rohilcund generally. It is situated at the confluence of the Jooah and Sunkra, and formed the capital of a Rohilla chief, who was slain at the battle of Cutterah, and who lies interred there. The travelling distance from Delhi is 142 miles; from Calcutta by Moorshedabad 910; from Lucknow 156 miles. Long. 70. 21. E. Lat. 28. 22. N. The district of Bareilly is bounded by the Ganges on the west, and is well watered by many other smaller rivers. The chief towns are Bareilly, Bissoneta, Anop-sheher, Moradabad, Rampoor, and Budayon. In summer, notwithstanding its northern latitude, the heat is intense; but in winter water sometimes freezes in the tents. After the cruel devastation of Rohilcund in 1774 by Sujah ud Dowlah, aided by the British troops, the country became a complete waste. In 1802 it was ceded to the British, and under their protection it was improved, and began to recover from the state of desolation into which it had fallen. The natives are a tall, handsome race of people, and white, compared with the more southern inhabitants of India. Rohilcund, Furruckabad, and the upper part of the country between the Jumna and the Ganges, abound with a warlike race of Mahomedans, the relics of that disorderly banditti of Pindarees or Patans who were crushed by the British armies in 1817. They are disaffected to the British because they have been forced to remain at peace, and to abandon their lawless habits of rapine for those of industry. The Mahomedan inhabitants of this district approach nearer to an equality of numbers with the Hindoos than in any other part of Hindostan, though even here they are still inferior.

Bardesa-
nists
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Bareilly.

Bareith
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Barkway.

BAREITH, a town of Germany, in Franconia, containing 10,000 inhabitants. It was formerly the chief town of a margravate of the same name. Long. 11. 50. E. Lat. 50. 0. N.

BARFLEUR, a town of France, in Normandy, now the department of the Channel. It was ruined, and had its harbour filled up by the English in 1346. The cape of that name is twelve miles east of Cherbourg, and near it part of the French fleet was destroyed in 1692. Long. 1. 6. W. Lat. 49. 40. N.

BARGA, a city of the province of Saluzzo, in the kingdom of Sardinia. It stands at the confluence of the rivers Infernetto and Ghiadone, and has three churches, two monasteries, and 7250 inhabitants, who are chiefly employed in the manufacture of fire-arms.

BARGAIN and SALE, a species of conveyance in the English law.

BARGE (*Bargie*, Dutch, from *Barga*, low Latin), a boat of state or pleasure, sometimes furnished with elegant canopies and cushions, equipped with a band of rowers, and decorated with flags and streamers. There are likewise barges of a smaller kind for the use of admirals and captains of ships of war. These are of a lighter frame, and may be easily hoisted into and out of the ships to which they belong.

BARGHMOTE, or BARMOTE, a court which takes cognizance of causes and disputes between miners. By the custom of the mines, no person is to sue any miner for ore-debt, or for ore, or for any ground in variance, but only in the court of barmote, on penalty of forfeiting the debt, and paying the charges at law.

BARI, a maritime province of the kingdom of Naples, bounded on the north by the Adriatic Sea, on the east and south-east by Otranto, on the south-west by Basilicata, and on the west by Capitanata. It extends over 1740 square miles, and contains a population of 324,600 persons. The capital, from which the province derives its name, is situated on a tongue of land on the Mediterranean Sea, and is well fortified with a strong citadel. It is ill built and somewhat filthy, and contains a cathedral, several churches, and other public buildings. In 1817 a lyceum was founded here, and there is also a college for the nobility. The inhabitants are about 20,000, including the suburbs. There are considerable manufactures of cotton goods, and much trade in soap, oil, almonds, potash, and cotton wool, the last of which is cultivated to a great extent near it. Long. 16. 52. E. Lat. 41. 15. N.

BARILLA, or BARILHA, the name of a plant cultivated in Spain for its ashes, from which the purest kinds of vegetable alkali or soda are obtained.

BARK, in the anatomy of plants, the exterior part of trees, corresponding to the skin of an animal. See ANATOMY, VEGETABLE.

BARK, or *Jesuit's Bark*, is a name given by way of eminence to the quinquina, or cinchona. See CINCHONA.

BARK, in *Navigation*, a general name given to small ships; it is, however, peculiarly appropriated by seamen to those which carry three masts without a mizen topsail. Our northern mariners who are trained in the coal-trade apply this distinction to a broad-sterned ship which carries no ornamental figure on the stern or prow.

BARKING, a market-town of the hundred of Beacontree, in the county of Essex, seven miles from London, on a creek which receives the river Rhoding, communicating with the Thames. It is in a rich marshy district, and its situation is considered unhealthy. The parish church is a large and handsome building. The inhabitants, of whom a large proportion are fishermen, amounted in 1801 to 1585, in 1811 to 2421, and in 1821 to 2580.

BARKWAY, a town of Hertfordshire in England, on

the great road from London to York. Long. 0. 5. W. Lat. 52. N. Barlæus
||
Barlow.

BARLÆUS, GASPAR, professor of philosophy at Amsterdam, and one of the best Latin poets of the seventeenth century. There was scarcely any thing great that happened in the world, while he lived, but he made a pompous elegy upon it, when reasons of state opposed no obstacle to it. He was a great defender of Arminius, and showed his abilities in history by his relation of what passed in Brazil during the government of Count Maurice of Nassau, published in 1647. He died the year after.

BARLETTA, a city in the province of Bari, in the kingdom of Naples. It is the seat of an archbishop, and was formerly fortified, but its defences are now in a dilapidated condition. It contains 17,950 inhabitants, who export much salt, made by evaporation in a large lagoon, and also considerable quantities of oil, wine, and almonds. The harbour is shallow, and all the water of the springs of rather a saline quality.

BARLEY. See AGRICULTURE and BREWING.

Pearl BARLEY and *French BARLEY*, barley freed of the husk by a mill; the distinction between the two being, that the pearl barley is reduced to the size of small shot, all but the very heart of the grain being ground away.

BARLEY-Water is a decoction of either of these, reputed soft and lubricating, and of frequent use in physic.

BARLEY-Corn is used to denote a measure, containing in length the third part of an inch, and in breadth the eighth. The French carpenters also use barley-corn, *grain d'orge*, as equivalent to a line, or the twelfth part of an inch.

BARLOW, WILLIAM, bishop of Chichester, descended of an ancient family in Wales, was born in the county of Essex. In his youth he favoured the Reformation, and travelled into Germany to be instructed by Luther and other preachers of the new doctrine. How long he continued a Protestant is uncertain; but from his letter to king Henry VIII. quoted below, it appears that he wrote several books against the church of Rome. However, he was a regular canon in the Augustine monastery of St Osith in the county of Essex, and studied some time at Oxford with the brothers of that order, where he took the degree of doctor in divinity. He was then made prior of the convent at Bisham in Berkshire, and afterwards succeeded to the several priories of Blackmore, Typtree, Lega, Bromhole, and Haverford-West. On the dissolution of abbeys, he not only resigned with a good grace, but persuaded several other abbots to follow his example. King Henry was so pleased with his ready obedience on this occasion, that he sent him in 1535 on an embassy to Scotland, in the same year made him bishop of St Asaph, in two months after translated him to the see of St David's, and in 1547 to that of Bath and Wells. During this time he was, or pretended to be, a stanch Papist; but when Edward VI. came to the crown, he again became a Protestant; and for that reason, on Queen Mary's accession, was deprived of his bishopric, and sent prisoner to the Fleet, where he continued for some time. At length he found means to escape, and immediately joined the other English Protestants in Germany. When Queen Elizabeth ascended the throne, our prelate was raised to the see of Chichester, and soon after made first prebendary of the collegiate church of Westminster. He died in 1568, and was buried in the cathedral of Chichester. He had five daughters, each of whom married a bishop. He wrote, 1. *The Buryal of the Masse*; 2. *The Climbing up of Fryers and Religious Persons, portred with Figures*; 3. *Christian Homilies*; 4. A book upon *Cosmography*; 5. *The Godly and Pious Institution of a Christian Man*, commonly called the *Bishop's Book*; and several other works. He

Barlow. is said to have translated the Apocrypha as far as the Book of Wisdom.

BARLOW, *William*, a mathematician and divine, the son of the bishop of Chichester, was born in Pembroke-shire, whilst his father was bishop of St David's. In 1560 he was entered a commoner of Balliol College, in Oxford; and in 1564 took a degree in arts, after which he left the university and went to sea, but in what capacity is uncertain: however, he acquired considerable knowledge in the art of navigation. About the year 1573 he entered into orders, and became prebendary of Winchester, and rector of Easton, near that city. In 1588 he was made prebendary of Lichfield, which he exchanged for the place of treasurer of that church. Some years after he was made chaplain to Prince Henry, the son of King James I., and, in 1614, archdeacon of Salisbury. He was the first writer on the nature and properties of the magnet. Barlow died in the year 1625, and was buried in the church at Easton. His works are, 1. *The Navigator's Supply*, containing many things of principal importance belonging to navigation, and use of diverse instruments framed chiefly for that purpose. London, 1597, 4to. 2. *Magnetical Advertisements*, or diverse pertinent observations and approved experiments concerning the nature and properties of the loadstone. London, 1616, 4to. 3. *A Brief Discovery of the Idle Animadversions of Mark Ridley, M. D.*, upon a Treatise entitled *Magnetical Advertisements*. London, 1618, 4to.

BARLOW, *Thomas*, born in 1607, was appointed fellow of Queen's College, Oxford, in 1633, and two years after chosen reader of metaphysics to the university. He was keeper of the Bodleian library, and in 1657 was chosen provost of Queen's College. After the restoration of King Charles II. he was nominated one of the commissioners for restoring the members unjustly expelled in 1648. He wrote at that time *The Case of Toleration in Matters of Religion*, to Mr R. Boyle. In 1675 he was made bishop of Lincoln. After the popish plot he published several tracts against the Roman Catholic religion, in which he showed an uncommon extent of learning, and skill in polemical divinity. Nevertheless, when the duke of York was proclaimed king, he took all opportunities of expressing his affection towards him; but after the Revolution he as readily voted that the king had abdicated his kingdom, and was very rigorous in excluding from their benefices such of the clergy as refused the oaths.

Mr Granger observes that "this learned prelate, whom nature designed for a scholar, and who acted in conformity with the bent of nature, was perhaps as great a master of the learned languages, and of the works of the celebrated authors who have written in those languages, as any man in his age. The greatest part of his writings, of which Mr Wood has given us a catalogue, are against popery; and his conduct for some time, like that of other Calvinists, appeared to be in direct opposition to the church of Rome. But after James ascended the throne, he seemed to approach much nearer to popery than he had ever done before. He sent the king an address of thanks for his declaration in favour of liberty of conscience, and is said to have written reasons for reading that declaration. His compliances were much the same after the Revolution. His moderation, to call it by the softest name, was very great; indeed, so great as to bring the firmness of his character into question. But casuistry reconciles seeming contradictions. He was, abstracted from this laxity of principles, a very great and worthy man." He died at Buckden, in Huntingdonshire, on the 8th of October 1691, in the 85th year of his age.

BARLOW, *Francis*, an English painter, was born in Lincolnshire. On his coming to London he was placed with

one Shephard, a limner; but his genius led him chiefly to the drawing of birds, fishes, and other animals. There are six books of animals from his drawings; and he painted some ceilings with birds for noblemen and gentlemen in the country. His etchings are numerous, but his illustration of *Æsop* is his greatest work. He died in 1702. There is something pleasing in the composition and manner of this master, though neither is excellent. His drawing too is very indifferent, nor does he characterize any animal justly. His birds in general are better than his beasts.

BARLOW, *Joel*, an American literary and political character of considerable note, was born in the year 1756, in the village of Reading, state of Connecticut, and appears to have been the youngest of ten children. His father died when he was yet a boy; but his friends, attentive to his instruction, employed his portion of the paternal inheritance for his education, at the College of New-haven, in his native state. Here he commenced his studies in 1774. In the course of the prescribed exercises of composition he discovered a taste for poetry, and two productions crept into public view, one entitled *The Prospect of Peace*; the other *An Elegy on the Death of Mr Hosmer*, member of the American congress. It appears that Mr Barlow was destined for the clerical profession; and that his friends solicited and obtained for him the appointment of chaplain to a militia company of Massachusetts, the functions of which he performed till the event of peace. One of his panegyrists has observed, in reference to his subsequent change of profession, that, "amongst the Presbyterians of New England, the priesthood is nothing else than a species of civil ordination. He who receives it may pass to another employment; and it is common enough to see young men preach the gospel in order to have time to prepare themselves for another profession." This explanation, however, is hardly reconcilable with the spirit of the New England theologians, who even now require from the candidate for holy orders a solemn declaration, that he is moved to this calling by a certain species of inspiration or divine impulse, and not by any carnal or interested motive.

In 1781, while he followed the army in quality of chaplain, he contracted a marriage with Miss Baldwin of New-haven; and it was during this period of his life that he planned the edifice of his future fame in his poem destined to celebrate the discovery and prospects of America. It was also during this period that the patriarchs of Connecticut proposed to adopt a new metrical translation of the psalms, which excited to emulation all the poetical genius of the state. The version of Barlow carried the prize, and is to this day sung in the churches of New England.

At the conclusion of peace between the United States and Great Britain, he abandoned the ecclesiastical life, and settled at the village of Hartford, where, two years afterwards, he published the poem alluded to, entitled *The Vision of Columbus*, which he afterwards gave to the world in a more expanded and imposing form.

After quitting the service of the church, he appears for some time to have practised law; but in 1788 he likewise abandoned that profession to become the agent of a mercantile company, who had purchased some millions of acres of land situated on or near the river Ohio, which they proposed to sell to foreigners at an enhanced price. For this purpose Mr Barlow was sent to Europe; and it is said that he was fortunate in the execution of this commission.

Having during this period become deeply interested by the events of the French revolution, he published, in the years 1791 and 1792, the following political pieces:—

Barlow.

Barlow. 1. Advice to the Privileged Orders. 2. The Conspiracy of Kings. 3. Letter to the National Convention of France. 4. The Royal Recollections. Towards the end of the year 1792, he, being then in London, was appointed by the Constitutional Society of London one of a deputation to present an address to the National Convention of France; a circumstance which attracted the notice of the British Parliament, it having been stated by a member that the Convention had received an address by means of two *fellows* calling themselves the representatives of Great Britain, viz. Frost and Barlow.

In 1793 Barlow, from motives of curiosity, accompanied the four commissioners of the National Convention who were sent to Mont Blanc to organize that department; and this excursion gave rise to another production, entitled *A Letter to the People of Piedmont*. About this time, also, he translated Volney's well-known work, entitled *Ruins of Empires*.

Objects of a commercial nature at length drew him to Hamburg, and afterwards to the coast of Africa, where he received the commission of consul-general of the United States, with instructions to enter into and conclude treaties with the Barbary powers for the purpose of procuring the ransom of the American citizens who were detained as slaves in those countries. The execution of this commission was prompt and fortunate; and, after residing for some time in Paris, to which he returned from Barbary, he, in 1805, proceeded to America, and purchased a neat habitation in the territory of Columbia, the seat of the general government, to which he gave the name of *Kahrama*. Here he formed an acquaintance with certain considerable members of Congress, to whom he greatly recommended himself by the publication of a short sketch of a plan of national education, and an address to the citizens of Washington upon occasion of one of the anniversaries of American independence. He now also published the superb quarto edition of his national poem, to which he finally gave the name of *The Columbiad*.

Soon after his return from Europe, he was admitted to the confidence of the first magistrate of the United States; and, in 1811, he received the valued appointment of minister-plenipotentiary to the court of France. This nomination met with powerful opposition in the senate, and passed only by a small majority.

He sailed for his destination on board of the Constitution frigate, disembarked at Cherbourg in September 1812, and proceeded to the French capital, where he was received, in the emperor's absence, by the minister of foreign affairs, who "was instructed to say the most flattering things relative to his appointment." The great object of his mission was to obtain compensation for the American property confiscated in virtue of the Berlin and Milan decrees. This arrangement was to be regulated in a manner the least onerous to the French treasury. American ships and cargoes were, at the same time, to be freed from unjust detention, and a new commercial treaty to be formed on principles of national justice and reciprocity.

In pursuit of this object he followed the Emperor Napoleon to Wilna in the memorable winter of 1812; but this diplomatic journey was without advantage, and the failure was the more mortifying, as it was undertaken without the advice or instructions of the American government. Mr Barlow was returning to Paris, when he was seized with a violent inflammatory disease, of which he died on the 26th of December, in the fifty-eighth year of his age. His nephew, a midshipman on board of the Constitution frigate, whom he took from his studies to accompany him in this journey, and a secretary of the French Legation in the United States, were witnesses of

his last moments, and saw him interred at the place where he closed his eyes, an obscure village of Poland.

BARM, the same with yest. See BAKING and BREWING.

BARMOUTH, a small market-town in the county of Merioneth, in North Wales, 223 miles from London. It is the only port in that division of the Welsh shore, and is much frequented in the summer as a bathing place, to which the picturesque scenery in the neighbourhood largely contributes. It is included in the parish of Corwen in the population returns, and thus the number of inhabitants cannot be ascertained, but they are estimated at about 1000.

BARN, in Husbandry. See AGRICULTURE.

BARNABAS'S DAY, St, a Christian festival, celebrated on the 11th of June. St Barnabas was born in Cyprus, and descended of the tribe of Levi, whose Jewish ancestors are thought to have retired thither to secure themselves from violence during the troublesome times in Judæa. His proper name was *Joses*, to which, after his conversion to Christianity, the apostles added that of *Barnabas*, signifying either "the son of prophecy" or "the son of consolation;" the first respecting his eminent prophetic gifts, the other his great charity in selling his estate for the comfort and relief of the poor Christians. He was educated at Jerusalem under the great Jewish doctor Gamaliel; which probably laid the foundation of that intimate friendship that afterwards subsisted between this apostle and St Paul. The time of his conversion is uncertain; but he is generally esteemed one of the seventy disciples chosen by our Saviour himself.

At Antioch Paul and Barnabas had a contest which ended in their separation; but what followed it with respect to Barnabas is not related in the Acts of the Apostles. Some say that he went into Italy and founded a church at Milan. It is generally believed that he suffered martyrdom at Salamis, where some Jews, having come out of Syria, set upon him as he was disputing in the synagogue, and stoned him to death. He was buried by his kinsman Mark, whom he had taken along with him, in a cave near that city. The remains of his body are said to have been discovered in the reign of the emperor Zeno, together with a copy of St Matthew's gospel, written with his own hand, and lying on his breast.

St BARNABAS'S Epistle, an apocryphal work ascribed to Barnabas, and frequently cited by Clement of Alexandria and by Origen. It was first published in Greek, from a copy of Father Hugh Ménard, a Benedictine monk. An ancient version of it was found in a manuscript of the abbey of Coebey, near a thousand years old. Vossius published it, in the year 1656, together with the epistles of St Ignatius.

St BARNABAS'S Gospel, another apocryphal work, ascribed to Barnabas the apostle, wherein the history of Jesus Christ is related in a manner very different from the account given us by the four evangelists. The Mahomedans possess this gospel in Arabic, and it corresponds very well with those traditions which Mahommed followed in his Koran. It was probably a forgery of some nominal Christians, and afterwards altered and interpolated by the Mahomedans, the better to serve their purpose.

BARNABITES, a religious order, founded in the sixteenth century by three Italian gentlemen, who had been advised by a famous preacher of those days to read carefully the epistles of St Paul. Hence they were called *clerks of St Paul*, and also *Barnabites*, because they performed their first exercise in a church of St Barnabas at Milan. Their habit was black, and their office to instruct, catechize, and serve in mission.

BARNACLES, in Farriery, an instrument composed of

Barn
||
Barnacles.

Barnard-Castle || Barnsley. two branches joined at one end with a hinge, to put upon horses' noses when they will not stand quietly to be shod, bled, or dressed.

BARNARD-CASTLE, a market-town in the parish of Gainsford and Darlington Ward, of the county of Durham, 247 miles from London, on the banks of the Tees. The market is held on Wednesday. A long and spacious street forms the principal part of the town, and its chief ornament is a handsome octagon market-house. The inhabitants amounted in 1801 to 2966 in 1811 to 2986, and in 1821 to 3581.

BARNES, JOSHUA, professor of the Greek language at Cambridge in the beginning of the eighteenth century. He was chosen queen's professor of Greek in 1695, a language which he wrote and spoke with the utmost facility. His first publication was a whimsical tract entitled *Gerania*, or a new discovery of the little sort of people called Pygmies. After this appeared his *Life of Edward III.*, in which he introduces his hero making long and elaborate speeches. He wrote several other books, particularly *Sacred Poems*; the *Life of Oliver Cromwell the Tyrant*; several dramatic pieces; a poetical paraphrase on the history of Esther, in Greek verse, with a Latin translation, &c. He also published editions of Euripides, Anacreon, and Homer's *Iliad* and *Odyssey*, with notes and a Latin translation. He wrote with greater ease in Greek than even in English, and yet he is generally allowed not to have understood the delicacies of that language. His death took place on the 3d of August 1712, in the fifty-eighth year of his age.

BARNET, or CHIPPING BARNET, a market-town in the hundred of Caisho and county of Hertford, 11 miles from London, on the great northern road. Near it, in 1471, was fought the decisive battle between the houses of York and Lancaster, in which the great Earl of Warwick fell. The market, held on Monday, is large, as well as the great cattle fairs. The inhabitants in 1801 amounted to 1258, in 1811 to 1579, and in 1821 to 1755.

BARNEVELDT, JOHN D'OLDEN, the celebrated Dutch statesman, and one of the founders of the civil liberty of Holland. His patriotic zeal inducing him to limit the authority of Maurice, prince of Orange, the second stadtholder of Holland, the partisans of that prince falsely accused him of a design to deliver his country into the hands of the Spanish monarch. On this absurd charge he was tried by twenty-six commissaries deputed from the Seven Provinces, condemned, and beheaded, in 1619. His sons William and René, with a view of avenging their father's death, formed a conspiracy against the stadtholder, which was discovered. William fled, but René was taken and condemned to die; which fatal circumstance has immortalized the memory of his mother, of whom the following anecdote is recorded. She solicited a pardon for René; upon which Maurice expressed his surprise that she should do that for her son which she had neglected for her husband. To this remark she replied with indignation, "I would not ask a pardon for my husband, because he was innocent; I solicit it for my son, because he is guilty."

BARNSLEY, or BLACK BARNSLEY, a town in the parish of Silkstone, of the wapentake of Staincross, in the West Riding of Yorkshire, 171 miles from London. It was formerly a place of considerable manufacture in iron, but

it has of late years become extensively engaged in making linen and other cloth. The trade has been greatly increased in consequence of the extension of canal navigation, which connects the town with Wakefield and the other canals and navigable rivers which unite at that place. There is a large market every Wednesday for cattle and corn. The inhabitants in 1801 amounted to 3606, in 1811 to 5464, and in 1821 to 8284.

BARNSTAPLE, a market and borough-town and seaport of the hundred of Braunton, in the county of Devon, 194 miles from London and 36 miles from Exeter. It stands on the river Tawe, in a fertile district, and was formerly a great manufacturing place, but of late years has declined in that branch of industry. The market, which is large, is held on Friday. Barnstaple returns two members to parliament, chosen by the freemen, who are very numerous, and scattered about in such various places as to render the expenses of a contested election very heavy; and it is said to be accompanied with much bribery. The inhabitants amounted in 1801 to 3748, in 1811 to 4298, and in 1821 to 5079.

BARO, or BARON, PETER, professor of divinity in the university of Cambridge in the sixteenth century, was born at Estampes, in France, and educated in the university of Bourges, where he was admitted a licentiate in the law; but being of the Protestant religion, he was obliged to leave his native country in order to avoid persecution, and, withdrawing into England, was kindly entertained by Lord Burleigh. He afterwards settled at Cambridge, and, by the recommendation of his noble patron, was in 1574 chosen Lady Margaret's professor there. For some years he enjoyed quietly his professorship; but a restless faction was at last raised against him, by his opposing the doctrine of absolute predestination; and this rendered his situation so uncomfortable, that he chose to leave the university and settle in London. He wrote, *In Jonam Prophetam Prælectiones xxxix.*; *De Præstantia et Dignitate Divinæ Legis*; and other pieces. He died in London about the year 1600.

BAROCCI, FREDERIC, a celebrated painter, was born at Urbino, where the genius of Raphael inspired him. In his early youth he travelled to Rome, where he painted several things in fresco. He then returned to Urbino, and giving himself up to intense study, acquired a great name in painting. His genius particularly led him to religious subjects. At his leisure hours, he etched from his own designs a few prints, which are highly finished, and executed with great softness and delicacy. The *Salutation* is his capital performance in that way; of which, however, we seldom meet with any impressions but those taken from the retouched plate, which are very harsh. He died at Urbino in 1612, aged 84.

BAROCHE. See **BROACH**.

BAROCO, in *Logic*, a term given to the fourth mode of the second figure of syllogisms. A syllogism in baroco has the first proposition a universal affirmative, but the second and third particular negatives, and the middle term is the predicate in the first two propositions. For example,

Nullus homo non est bipes:
Non omne animal est bipes:
Non omne animal est homo.

Barnstaple || Baroco.

BAROMETER.

Barometer. OUR dictionaries contain such an account of the discovery and construction of this most valuable instrument, as can be drawn from the popular treatises of natural philosophy in the English language. But, unfortunately, the compilers of elementary works have seldom taken the trouble to remount to the original sources of information, and have frequently, by substituting their own fancies, or servilely copying the mistakes of others, contrived to disfigure egregiously the relation of facts, and the history of the progress of invention. We purpose, therefore, as far as our limits will admit, to discuss the subject with more careful research; but, passing rather lightly over the description of the different kinds of barometers and other practical details, to dwell more especially on the successive steps which led to the fine discovery of atmospheric pressure and its application to physical science.

Opinions
of the
ancients;

The opinions entertained by the ancients concerning physical subjects appear at best only splendid visions. They speculated boldly in cosmological theories, but were easily satisfied with those conclusions which merely soothe the fancy. Many of the philosophical notions adopted in remote ages have, however, left a durable impression in the structure of language, and still continue to exercise a visible influence in moulding the current sentiments of mankind. The early sages of Greece distinguished matter into the four primary elements, of *earth, water, air, and fire*, which, by their various combinations, were supposed to produce the animated spectacle of the universe. With these elements were associated corresponding qualities, in a binary conjunction; *hot and cold, dry and moist*. *Earth and water* were considered as ponderous and inert; but *air and fire*, endued with elastic virtue, were imagined to possess lightness and activity. *Fire*, though extracted from all bodies by the operations of nature or of art, was yet conceived to be derived, by invisible emanation, from that diffuse lambent fluid which, under the name of *Æther*, occupied the highest heavens, and furnished the substance and nutriment of the celestial bodies. While the earthy matter would, therefore, naturally settle towards the centre, and the aqueous fluids roll along the surface of the solid globe, the air and fire soared aloft; the former occupying the whole of the region below the moon, and the latter streaming through the boundless extent of space. This *sublunary* scene is exposed to incessant change, calamity, and decay; but above it was supposed to reign a perpetual calm, the seat of bliss, and of divine and imperishable essence.

Aristotle and some other philosophers, viewing *æther* as altogether distinct from *culinary fire*, were disposed to consider it as a *fifth* element, of a pure, divine, and incorruptible nature; an opinion which afterwards gave occasion to the famous *Quinta Essentia*, or *Quintessence* of the schoolmen. The alchemists, who sprung up nearly about the same benighted period, in adopting these notions, modified them to suit their own peculiar views. To the elements commonly received, they joined the active auxiliaries of *mercury* and *sulphur*. For *quintessence* they substituted *spirit* and *elixir*; the former, drawn off by the application of fire, being conceived to represent the animating principle of each body; while the latter, extracted by the combined action of heat and moisture, was supposed to exhibit its concentrated and most select qualities.

Some of the ancient cosmologists imagined a vacuum beyond the shining expanse of *æther*, destined to receive

the exhalations from this nether world. Others denied the existence of a separate void, but admitted small vacuities interspersed through bodies. Aristotle, however, maintained the necessity of a plenum, asserting that our idea of space or extension is inseparable from that of body. To this principle he ascribed the suspension of water in a tube, when the finger is applied to shut the upper end. Yet the very contempt in which that philosopher, from a consciousness of his own superiority, was accustomed to hold the received opinions, might have led him to take juster views. He rejected the notion that air has levity inherent in its nature; nor would he admit the more plausible idea, that a fluid so easily moved must possess the quality of perfect indifference, and be neither light nor heavy. Aristotle not only maintained that air is ponderous, but did not scruple to appeal to direct experiment in support of this assertion. A bladder, he says, will be found to gain some weight, on being blown or filled with air. But this was evidently a mere random assertion, betraying his ignorance of the constitution of fluids. A bag filled with air, and suspended in a like medium, it is obvious, from the laws of hydrostatics, must weigh exactly the same as before. If it be alleged that, in blowing up the bladder, a portion of air would be introduced immediately from the lungs, and containing therefore a small admixture of carbonic acid gas, which is specifically heavier than the common atmospheric fluid; the additional weight, amounting scarcely perhaps to a grain, would be too minute to be detected by any of the jewellers' balances constructed in ancient Greece.

The mutual opposition of the leading philosophical sects of antiquity had, in general, most fatally discouraged the application of mathematical reasoning to the system of the material world. The Academicians, or the disciples of Plato, who cultivated geometry with ardour and brilliant success, were disposed to regard that science as a pure intellectual contemplation; and resigning themselves to the illusion of their lofty dreams, they turned with disdain from the investigation of individual facts and all the vulgar realities of life. The mind of Aristotle was of a more sober and practical cast; acute, profound, and discriminating; it ranged with incredible industry over an immense field of inquiry. That judicious philosopher recommended a careful and constant appeal to external observation, as the only sure ground on which to erect the structure of physics; but unfortunately his scholars neglected too much the study of mathematics, the most powerful instrument for conducting physical research. The precepts of Aristotle, though excellent in some respects, were hence in the sequel unproductive of any genuine fruit. On the contrary, the weight of his opinions, during a long course of ages, repressed the efforts of human genius.

It must be gratefully acknowledged, that the alchemists, styled also *philosophers by fire*, were the first among the moderns who dared to explore new paths of science. Their projects were, indeed, highly chimerical, but they had the merit at least of setting the example of investigating the properties of matter by actual experiment. They likewise formed associations among individuals for the more effectual prosecution of such researches. Hence the origin of that obscure sect known by the fanciful title of *Rosicrucians*, who sprung up in Germany, and insensibly spread their influence over the Continent. Those principles were afterwards transplanted into the matured

Barometer.
Physical
tenets of
Aristotle.

Modern
experi-
mentalists.

Barometer. soil of Italy, where philosophy, succeeding to the cultivation of letters, wore a more attractive garb. Baptista Porta, a Neapolitan nobleman, who flourished about the latter part of the sixteenth century, was particularly distinguished by his zeal in promoting such pursuits. Having spent many years in travelling over Europe to gain information respecting natural objects, he invited a few individuals of a congenial taste to assemble at stated times in his house, and assist him in making new experiments. These meetings, however, gave umbrage to the watchful jealousy of the clergy, and they were soon suppressed by a mandate from the court of Rome. But the example was imitated in other parts of Italy, where the papal authority enjoyed less respect; and academies for the promotion of natural science were successfully instituted under the patronage of different princes, especially those of the illustrious house of Medici.

Galileo. In this ferment of inquiry, Galileo arose, a man fitted alike by the gifts of nature and the lights of education to be the founder of experimental science. His elegant genius was invigorated by the study of the Greek geometry; and he conceived the happy and prolific idea of employing that refined instrument to explore facts and combine the results. Archimedes, indeed, among the ancients, had anticipated this road of discovery, having most successfully applied the powers of geometrical analysis to the investigation of some parts of mechanics and hydrostatics. But his was a solitary instance, unheeded by succeeding ages. The ingenuity of Galileo prepared a complete revolution in science. By means of a few simple but striking experiments performed on the lagoons of Venice, he established the laws of motion, which he now transferred from the surface of our globe, to direct the revolutions of the heavenly bodies. The publication of his *Dialogues*, which unfold the right process of induction, and are not less distinguished by fineness of conception than beauty of diction, forms a new era in the annals of philosophy. He was the first who attempted to ascertain the weight of air by actual experiment; and considering the nicety of the operation, and the rudeness of the instruments constructed at that period, he made a very tolerable approach to the truth. It had been known for many ages that air is capable of being highly condensed; and Ctesebius of Alexandria had invented an engine, which, by the force of the sudden expansion of this compressed fluid, hurled missile weapons. This was afterwards improved into the wind or air-gun, which seems to have been not uncommon in Europe as early as the fifteenth century, though soon afterwards generally superseded in practice by the introduction of fire-arms. Galileo, being led by a different path from that pursued at present, set himself to examine the weight which air acquires by condensation. Having fitted a large copper ball with a valve, he injected air into its cavity by means of a syringe, and then suspended it to a balance. The additional increase of weight being thus found, he opened the valve under an inverted glass receiver full of water, and measured, by the displacement of this liquid, the surplus quantity of air which had been injected into the copper vessel.¹ He thence concluded that air is 400 times lighter

than water, being about the double of the true estimate; Barometer. an error probably arising from some imperfection of the valve that confined the air within the ball.

After he had, by such researches, acquired celebrity in the scientific world, Galileo accepted an invitation, with a very handsome appointment, from Cosmo de' Medici; and devoting himself intensely to astronomical observations, aided by the telescope, which, from an obscure hint, he had recently constructed, yet occasionally unbending his mind with elegant recreation, he spent almost the whole of the evening of his life at the villa of Arcetri, near Florence, in a style of comfort and even splendour. But, while occupied with those delightful pursuits, exploring the planetary phases, and discovering new worlds, he was for a moment recalled to his early studies by an incident destined to form an epoch in the history of physical science. Some artisans, in the service of the grand duke, Incidental having been employed to construct a lifting or sucking failure of a pump for a very deep well, found, with equal surprise and sucking pump. vexation, that, in spite of all the pains they had taken in fitting the piston and valves, the water could by no effort be made to rise higher in the barrel than eighteen palms, or thirty-two feet. In this dilemma they applied to Galileo for an explication of the cause of a failure then so unexpected and perplexing. But the philosopher was not yet prepared to encounter such a discordant fact. The Aristotelian tenet of the impossibility of the existence of a void, was, at this period, universally received as an unquestionable truth. It had become a favourite axiom of the schoolmen, deceiving themselves, as Leibnitz did afterwards in proposing his principle of *sufficient reason*, by the glimmer of a metaphorical expression, the *fuga vacui*, or *nature's horror of a void*. To create a vacuum, they gravely maintained, would require the hand of Omnipotence, transcending the utmost power of men or even devils. But Galileo, though borne along by the current of opinion, saw the necessity of at least modifying the general principle. Without questioning nature's abhor-Timid and rence of a vacuum, he supposed the influence of this hor-imperfect ror to be confined within certain limits, not exceeding the explication of Galileo. pressure of a column of water eighteen palms in height. This was evidently evading, rather than meeting, the difficulty proposed for his solution. Yet, in the last of his *Dialogues*, he actually mentions an experiment to ascertain this power, or *virtù*, as he calls it, of a vacuum. A piston with a valve, exactly fitted into a smooth hollow cylinder, was rammed quite to the end, and this carefully shut up; then placing the cylinder in an upright but inverted position, successive weights were appended to the rod, till it was drawn from the close end, and pulled down. It may seem strange that the Tuscan philosopher, after advancing so far, should have stopt on the verge of a great discovery. He had already weighed the air, and it was only another small step thence to infer the effect of its incumbent mass. But the atmosphere was still believed to reach to the moon, and the pressure of columns of such enormous altitude seemed to mock all calculation, and overwhelm the imagination.² Yet, on reconsidering the subject, Galileo began to suspect the solidity of the explication which he had given; but it was now too late for

¹ From this remarkable experiment it is easy to perceive that Galileo was really the inventor of our pneumatic apparatus, though his title has been so long overlooked by chemists.

² This narrative, which marks so well the slow and timid steps whereby men, even of the highest intellectual endowments, usually advance in the search after truth, is drawn from the writings of Galileo himself. The carelessness of some authors in mis-stating facts, and imputing unworthy motives to those patriarchs of science who could not open their eyes all at once to the bright effulgence of day, deserves severe reprehension. We may remark, in passing, that M. Biot, who ranks among the first mathematicians and philosophers in France, has not scrupled, in an elaborate compilation on physics, to allege that Galileo merely joked with the artisans who asked him the reason of the failure of their pump; that he had an idea of the true explication, but chose to keep his secret, and suffer it to die with him. Such conduct would certainly have been a reproach to Galileo's acknowledged candour.

Barometer. him, in his advanced age, loaded with bodily infirmities, and dispirited by clerical persecution, to attempt any further innovation in science. Recommending it earnestly to his friend and pupil Torricelli to resume the investigation, this illustrious precursor of Newton expired in 1642, the very year in which the English philosopher was born. His uniform kindness and urbanity rendered him extremely beloved; and his disciples, particularly Torricelli, Viviani, and Ricci, venerating his memory, caught the same taste, and followed similar pursuits.

Torricelli's famous experiment. Torricelli now conceived the happy idea of exhibiting the action of a pump on a contracted scale, by means of a column of mercury, which is nearly fourteen times heavier than water. This experiment he first communicated to his friend Viviani, who performed it with success in 1643; and he afterwards repeated and varied it himself. The method which he adopted brought very neatly under one view all the circumstances affecting the question. Having selected a tube about a quarter of an inch wide, and four feet long, he sealed one of the ends hermetically, or closed it under the flame of a lamp; he then filled the cavity of the tube with mercury, and applying his finger to the open end, he inverted it in a basin likewise containing mercury, though covered with a portion of water. The mercury instantly sunk to nearly thirty inches above the lower surface; but on raising the tube, till its orifice communicated with the layer of water, the mercury ran all out, and the water now sprung up to the top, and occupied the whole of the cavity. It was thus proved, that the water and mercury are each supported by the same equipoise, which Torricelli, after some hesitation, at last concluded to be the pressure of the external atmosphere. He next converted the mercurial column into a form adapted for observation, by bending the lower end of the tube, and constructing what has since received the name of the *syphon barometer*. (See fig. 1. Plate CVI.) Thus provided with a commodious instrument, he soon detected the variation of atmospheric pressure, which depends on the change of weather. These important results were published in the year 1645; but Torricelli did not live to enjoy the fame of his great discovery, for this most promising genius was snatched away by a putrid fever in the flower of his age.

The report of Torricelli's first experiments having been carried to France before he had ventured to draw his capital conclusion, set philosophers to speculate on the cause of such an unexpected fact. Descartes, with his usual rapidity and boldness of conception, did not hesitate, in his correspondence with Mersenne, to refer the suspension of the mercury in the tube at once to the pressure of the external atmosphere. But this inference appears not very consistent with his system, which assumed the existence of an absolute plenum, and only supplied the place of a void by the diffusion of subtile abraded particles of matter. He suspected, besides, the accuracy of Galileo's estimate of the weight of the air, which he thought could be scarcely appreciable by experiment.

Pascal's experiments.

But, in the same country, the subject was now pursued with deliberate caution, and through all its details, by another genius of the highest order; one of the finest and most original that France has ever produced. Pascal had shown premature and extraordinary talents, which were encouraged by his father, a man of learning, who lived in habits of intimacy with the literati of Paris. The young philosopher happened to be residing at Rouen, in 1646, when he was informed of the famous Italian experiment. Having access, fortunately, to a glass-house, he resolved immediately to repeat the observations on a large scale. He had already suspected the justness of the principle, that "nature abhors a vacuum," and thought that the condensa-

tion and rarefaction of the air point to a different, or at least Barometer. a modified conclusion. With a view to clear up this subject, Pascal performed a number of satisfactory experiments, of which we shall cite a few of the more striking, nearly in his own language, tinged evidently with the prevailing opinions of the age:—1. Having fitted a piston to an open glass tube, and rammed it quite down, he applied his finger close to the lower end, and plunged the whole under water; then drawing back the piston, which was done with ease, the finger felt strongly and rather painfully *attracted*, while an *apparent vacuity* was formed above it, and continued to enlarge; but instantly on removing the finger, the water, *contrary to its nature*, darted up and filled the whole of the cavity. 2. A glass tube, about fifty feet long, sealed hermetically at one end, and filled with water, or rather red wine, as a more visible fluid, was inverted perpendicularly in a basin of the same. The liquid immediately subsided, leaving a vacant space of thirty-five feet; but on gradually reclining the tube, the liquid rose again, and continued to mount, till it struck a sharp blow against the top of the glass. 3. A syphon, having one leg fifty-five feet high, and the other only fifty, being filled with water, and planted in two basins containing the same, such that the shorter branch had a perpendicular position, the water sunk in both to the same level, without being *attracted*, as usual in syphons, to the longer branch; but, on leaning the syphon back, the columns rose till they united at the top, and then the water began to flow towards the lower basin. The same experiment was also performed with mercury, the syphon having one leg ten feet, and the other only nine feet and a half in length, the mercury being found to divide itself into two columns, which continued suspended at an altitude of about thirty inches. 4. Having nicely fitted a piston to a long glass syringe, and pushed it down to the end, he immersed this in a basin of mercury, and held the tube in a vertical position; on gently drawing up the piston, the mercury closely followed it to the height of twenty-nine inches, but then stopt, leaving the piston to form above it an *apparent vacuity*. In this state, also, the syringe weighed exactly the same, whatever was the magnitude of the vacant space.

From these and other similar experiments, Pascal led His cautious inductive process, with a degree of caution that might seem to border on timidity. He inferred that all bodies have a *reluctance* to a visible separation, or that nature abhors an apparent void; that this reluctance is exactly the same for a small as for a great vacuity; and that the force is limited, and exceeds not the pressure of a column of water thirty-three feet in height. He next ventured one step farther, and concluded, that this apparent vacuity was not filled by air lodged in the pores of the glass, or derived from external filtration; that it contained no subtile matter secreted from the atmosphere, and was not occupied by mercurial vapours or spiritous exhalations; in short, that a real and absolute vacuum had been formed.

Pascal, then only twenty-four years of age, proposed to write a treatise on the subject of those inquiries; but by Noël. He thought proper, in the mean time, to publish a short abstract of it, which appeared in 1647, and involved him in a wretched controversy. Father Noël, rector of the Jesuits' College at Paris, keenly attacked it, armed with all the miserable sophisms of the schools, and the absurd dogmas of the Romish church. He contended, that the space above the mercurial column was corporeal, because it was visible and admitted light; that a void being a mere non-entity, cannot have different degrees of magnitude; that the separation produced in the experiments was violent and unnatural; and he presupposed that the atmosphere, like blood, containing a mixture of the seve-

Barometer. ral elements, the fire and the finer part of the air were detached from it, and violently forced through the pores of the glass, to occupy the deserted space. To enforce these puerile arguments, the reverend prelate did not scruple to employ the poisoned weapon which his order has often wielded with deadly effect, namely, hinting an oblique charge of heresy. This rude attack only roused Pascal, and disposed him boldly to throw off the fetters of inveterate opinion. He began to perceive that "*abhorrence*" cannot, in strict logic, be applied to nature, which is a mere personification, and incapable of passion; and was inclined, by degrees, to adopt the clear disembarassed explication of Torricelli, referring the suspension of the mercurial column to the pressure of the external atmosphere. In stating this conclusion, he makes some remarks which would deserve the serious attention of philosophers in the present age. "When the weakness of men is unable to find out the true causes of phenomena, they are apt to employ their subtilty in substituting imaginary ones, which they express by specious names that fill the ear, without satisfying the judgment. It is thus that the sympathy and antipathy of natural bodies are asserted to be the efficient and unequivocal causes of several effects, as if inanimate substances were really capable of sympathy and antipathy. The same thing may be said of the antiperistasis, and various other chimerical causes, which afford only a vain relief to the avidity of men to know hidden truths, and which, far from discovering them, only serve to conceal the ignorance of those who invent such explications, and nourish it in their followers." These remarks, equally judicious and profound, are the more striking, since Lord Bacon, while he proposed to reform and new-model the whole structure of human learning, yet complied with the taste of his age in retaining much of the jargon and barbarous distinctions of the schools.

Pascal's
decisive
experiment.

But Pascal did not rest satisfied with mere reasoning, however strictly conducted; and he soon devised an experiment which should palpably mark, under different circumstances, the varying effects of atmospheric pressure. It occurred to him, that, if the mercury in the Torricellian tube were really supported by the counterpoising weight of the atmosphere, it would be affected by the mass of superincumbent fluid, and must therefore partially subside in the higher elevations. He was impatient to have his conjecture tried in a favourable situation; and, in November 1647, he wrote a letter communicating those views to his brother-in-law, Perier, who held an office of considerable trust in the province, and commonly resided at Clermont in Auvergne, in the immediate vicinity of the Puy de Dôme, a lofty conical mountain, which rose, according to estimation, above the altitude of 500 toises. Various avocations, however, prevented that intelligent person from complying with his instructions till the following year. Early in the morning of the 19th September 1648, a few curious friends joined him in the garden of a monastery, situated near the lowest part of the city of Clermont, where he had brought a quantity of mercury, and two glass tubes hermetically sealed at the top. These he filled and inverted, as usual, and found the mercury to stand in both at the same height, namely, 26 inches and $3\frac{1}{2}$ lines, or 28 English inches. Leaving one of the tubes behind, in the custody of the subprior, he proceeded with the other to the summit of the mountain, and repeated the experiment, when his party were surprised and delighted to see the mercury sink more than three inches under the former mark, and remain suspended at the height of 23 inches and 2 lines, or 24.7 English inches. In his descent from the mountain, he observed, at two several stations, that the mercury successively rose; and, on his return to

the monastery, he found it stood exactly at the same point as at first. Encouraged by the success of this memorable experiment, Perier repeated it on the highest tower of Clermont, and noted a difference of two lines at an elevation of twenty toises. Pascal, on his part, as soon as the intelligence reached him at Paris, where he then chanced to be, made similar observations on the top of a high house, and in the belfry of the church of St Jacques des Boucheries, near the border of the Seine; and so much was he satisfied with the results, that he proposed already the application of the barometer for measuring the relative altitudes of distant places on the surface of the globe.

The investigation of the existence and effects of atmospheric pressure was now completed, and it threw a sudden blaze over the whole contexture of physical science. The fame of the experiments performed in Italy and in France, quickly spread over Europe. Yet such is the force of habit and early prejudice, that, after the first moments of surprise and confusion, few of the learned at this period had the courage to open their eyes to the light which had so unexpectedly burst upon them; but, secretly cherishing their inveterate notions, they sought to comfort themselves by starting a variety of captious objections. Father Mersenne, though a man of some abilities, conceived that suction was occasioned by certain hooked particles dispersed through the atmosphere, which laid hold of any fluid in contact with them, and drew it towards the general mass. Father Linus, plunging still deeper in mysticism and absurdity, gravely proposed the *funicular hypothesis*, which attributes the suspension of the mercurial column to the agency of certain small invisible threads. But others of the clergy attacked Pascal with envenomed bitterness. The Jesuits of the college of Montserrand scrupled not, in their public theses, to pervert his expressions, and even contest the originality of his experiments. The philosopher was justly incensed at their base conduct; and those repeated provocations served, no doubt, to give a keener edge to his wit, when he afterwards directed it with such overwhelming force against that insidious and formidable order of priesthood. He composed in 1653, though they were not published till after his death, two short treatises, *On the Equilibrium of Liquors*, and *On the Weight of the Mass of Air*, remarkable for their neatness, perspicuity, and lucid order. The laws of the equilibrium of fluids are there beautifully deduced from a single principle, which suggests a variety of original views and admirable remarks. In those tracts he likewise gives a description of the Hydraulic Press, a most useful and powerful machine, which has lately been revived in this country, and by some considered as a new invention.

Opposition
which it
experienced.

A similar discovery, which was made about the same time in Germany, came seasonably to support the triumph of innovation. Otto Güricke, a wealthy magistrate of Magdeburg, who amused his leisure by constructing pieces of mechanism, and instituting curious physical inquiries, finding that the belief in the impossibility of a vacuum, with other scholastic tenets, was on the gradual decline, had the boldness to conceive that the forming of a void was a task perhaps within the reach of human ingenuity. Fired with the idea of accomplishing what for ages had been deemed unattainable, he directed all his efforts to compass that end. In his first trials he failed, as might be expected; but, by perseverance, he was enabled to surmount every obstacle. Having filled a wooden cask with water, he attempted to extract this again, by means of a small sucking pump, introduced at the bottom of the cask, and worked vigorously by three stout men; a hissing noise was heard like that of boiling

Discovery
of the air-
pump by
Güricke.

Barometer. water, the air entered from above through the interstices of the wood, and the water flowed out. The more effectually to exclude the air, he next took a smaller cask, with a sucker attached to it, and placed it within a larger one, having filled up the space between them with water. On working the pump as before, the water was forced through the pores of the wood into the inner cask, but none was extracted by the action of the piston. Foiled in these attempts with wooden casks, he had recourse to a copper ball, to the under part of which he screwed an inclining sucker; and, with this apparatus, he at last succeeded in extracting the air. He continued the operation, till no further portion of air was perceived to issue from the vent. On opening the cock again, the air rushed into the cavity of the ball with violence; and the same effect took place, with scarcely any diminution of power, after an interval of a day or two. The construction of the machine was afterwards rendered more perfect, by substituting a large inclined metal sucker, with its joints secured by immersion in water.

Such was the origin of that most valuable addition to philosophical apparatus, the air-pump, which long retained its earliest rude and simple form on the Continent. By help of this new and powerful instrument, G urick  was enabled to perform some interesting and very important experiments. One of these, which demonstrates in a very striking way the pressure of the atmosphere, has since been deservedly styled the Magdeburg Experiment. It was performed with two hollow copper hemispheres, closely fitted together, and the air exhausted from their cavity. This singular experiment G urick  had the honour of exhibiting, in the year 1654, before the princes of the empire and the foreign ministers, assembled at the diet of Ratisbon. The force of two teams, each consisting of a dozen of horses, made to pull in opposite directions, was found insufficient to separate the hemispheres. It was now that the burgomaster of Magdeburg heard, for the first time, of Torricelli's great discovery, and the intelligence must have appeared quite delightful to him, who, by a path so different, had yet arrived at a similar conclusion.

After his return from this splendid assembly, G urick  pursued at home various pneumatical researches. He showed the diminished pressure of the atmosphere at an elevation above the surface, by means of a hollow ball fitted with a stop-cock; having carried this to a height, a portion of the contained air rushed out on turning the cock; but when it was brought down again and opened, the same measure of air apparently flowed into its cavity. He actually weighed the air by ascertaining, with the help of a nice balance, the loss which a large bottle sustained on being exhausted, and found that the air is 970 times lighter than water; a very near approximation, if allowance be made for the residuum of air still left in the bottle. He was the first who proposed the *Statical Balance* for measuring the variations of atmospheric density, consisting of a hollow glass ball about a foot in diameter, hermetically sealed, and freely suspended in the air, to indicate by its different buoyancy the changes which take place in the gravity of the external fluid.

Statical
balance.

But G urick  took great pleasure in a huge water barometer erected in his house.¹ It consisted of a tube above thirty feet high, rising along the wall, and terminated by a tall and rather wide tube hermetically sealed, contain-

ing a toy, of the shape of a man. The whole being filled with water, and set in a basin in the ground, the column of liquid settled to the proper altitude, and left the toy floating on its surface; but all the lower part of the tube being concealed under the wainscoting, the little image, or weather-mannikin, as he was called, made its appearance only when raised up into view in fine weather. This whimsical contrivance, which received the name of *ane-Anemo-mosope*, or *semper vivum*, excited among the populace vast admiration; and the worthy magistrate was in consequence shrewdly suspected by his townsmen of being too familiar with the powers of darkness.

Before the taste for experimental science was imported from the Continent into England, the great struggle for the security of public rights had called forth the national energy, and its triumphant success had infused among all classes of men a spirit of boldness and enterprise most favourable to the reception of the new philosophy. The parliamentary commissioners, by removing the more violent and bigoted members of the universities, contributed, on the whole, to encourage a more liberal tone of thinking in those opulent seminaries. Near the close of the civil war, and during the vigorous administration of Cromwell, the philosophy by experiment found some proselytes at last in the cloisters of Oxford, where the mass of antiquated opinions had lain so long embalmed and protected by religious awe. A small association was there formed, for combining together the efforts of individuals in the prosecution of such inquiries; and the fruits of this mutual compact were afterwards visible in the composition of various philosophical works. But the Restoration, by which the nation, in a burst of inconsiderate loyalty, surrendered the privileges which it had purchased with torrents of blood, threw the government of the universities again into the hands of men decidedly hostile to the very shadow of improvement. Experimental science withdrew to a more congenial soil, and sought shelter and support in the wider scope of the capital. The college, founded by the munificence of Sir Thomas Gresham, for the benefit of the citizens of London, though now unfortunately sunk in absolute neglect, had the merit of being the first to extend its protection to the pursuits of inductive philosophy. It produced a succession of professors, eminent in mathematical learning, which is so closely allied with experimental research. A more extensive association was accordingly formed in London, which regularly met at the apartments within the Exchange, and was afterwards, at the suggestion of Oldenburg, the resident from the city of Hamburg, and in imitation of the foreign academies, constituted by charter into the Royal Society. Such was the humble beginning of that illustrious body, and such all the countenance it received from a needy and profligate government. The institution, however, proved at first eminently useful, by its influence in directing public opinion, and the shelter it afforded to experimental philosophy against the jealousy and declared hostility of the clerical and scholastic seminaries. The union of rank, or wealth, or talent, though still very limited in its range, bestowed a degree of lustre on the infant society, that was quite necessary for its defence against the attacks of ignorance and the undermining of bigotry.

One of the most active members of the Royal Society was the honourable Mr Boyle, who having become acquainted with experimental researches in the course of

¹ It deserves perhaps to be mentioned, that the theatre of the natural philosophy class, in the University of Edinburgh, has for several years been furnished with a water barometer, constructed by Mr Adie. It consists of a fine drawn tube of tin, of half an inch bore, rising thirty feet from a copper basin inclosed under the benches of a class below, and cemented at the top to a glass cylinder two inches wide and about six feet high, exposed to view, but terminating in a small basin containing water. Both ends of this compound column are fitted with stop-cocks, which are opened or shut at pleasure by means of concealed wires. By this large apparatus the Torricellian experiment is likewise exhibited in a very striking manner.

Barometer. his travels, devoted, after his return home, his time and his fortune to such calm but engaging pursuits. In this occupation he derived the most essential aid from Dr Hooke, whom he had the discernment to engage as his assistant,—the most skilful mechanic, and one of the best practical philosophers, of the age. The same ingenious person was likewise employed as operator to the society, and undertook to produce at each meeting some new experiments for the instruction and entertainment of the members. One of the favourite subjects was to exhibit the properties of the atmosphere. Hooke, at the instance of Boyle, had given a more convenient form to the air-pump, and had materially improved its construction, especially by the application of oil to the joints and valves. With this improved machine, a more perfect vacuum was procured than Gùrické had obtained; and the English philosophers were thus enabled to perform a variety of delicate and interesting experiments, which extended the influence of the original discovery.

In those early meetings, too, of the Royal Society, the suspension of the mercury in the Torricellian tube had still the attraction of novelty. The famous Italian experiment, as it was called, was frequently repeated and varied in the presence of a few of the more assiduous members, who, though delighted with the exhibition, still continued to argue and to doubt concerning the cause of the phenomenon. These doubts acquired new force from a singular experiment which the celebrated Huygens some years afterwards communicated, during a visit he made to London. Having filled a glass tube eighty inches long with mercury, and carefully expelled whatever air was lurking about the sides, he gently inverted it, as usual, in a basin; when the mercury notwithstanding remained still hanging from the top of the tube, and did not subside to the proper height till it was struck with a slight blow. This anomalous fact appeared then extremely puzzling. The experiment, indeed, requires great nicety and address on the part of the operator, and evidently depends on a concurrence of circumstances which have not yet been sufficiently explained. There can, at present, exist no doubt that this extraordinary suspension of the mercury is occasioned by its obstinate adhesion to the inside of the tube, which, in the process of purging the air, becomes probably lined with a very thin film of mercurial oxyd. But Huygens, who had embraced the leading principles of the Cartesian philosophy, was inclined to draw a very different conclusion. He thought that the fact proved the existence of another fluid besides the atmosphere, and one possessed of such extreme subtilty and power, as to be capable of permeating the grosser bodies. In ordinary cases, this fine ethereal substance might be supposed to escape through the pores of the glass, and leave the mercurial column to the pressure merely of the atmosphere. Such was the unfortunate introduction of that ideal being—an æther—into experimental science, which it has continued to infest with mysticism, and to dazzle with a false glare. Similar notions are perpetually renewed by a certain class of superficial inquirers, and have exercised a visible and most pernicious influence in retarding the progress of sound philosophy.

Cistern barometer. It was soon perceived that the syphon barometer of Torricelli has a disadvantageous form. Both branches of the tube being assumed to be of the same width, the mercury must evidently sink as much in the one as it will rise in the other; so that the variations in the height of the column are thus reduced to half the true quantity. A small basin, or semicircular wooden box, to hold the surplus mercury, was therefore attached to the frame of the instrument; and this construction, with very little change, was adopted, during the course of a century, by the ma-

kers of the ordinary barometer. But the syphon barometer itself was afterwards materially improved by having its lower branch blown into a wide bulb for holding the charge of mercury. (See fig. 2, Plate CVI.) This form of the barometer is not quite accurate, owing to the smallness and unequal shape of the round bulb; but being very convenient for carriage, it has grown into general use, at least for the cheaper and more common sort of instruments.

As soon as the barometer came to be regarded as a Barometer weather-glass, ingenuity was set at work to devise the means of enlarging its scale of variations. Descartes first proposed a simple method for effecting that object, by combining a mercurial with a water barometer; which arrangement, though subject to imperfection, has led to many of the subsequent improvements. (See fig. 4.) He directed two short barometric tubes to be cemented, the one into the bottom, and the other to the neck of a phial; or, still better, that the tubes should be joined, by the flame of a lamp, to the opposite ends of a wide and regular cylinder. The lower tube, and a portion of the cylinder, were then to be filled with mercury, and above it was to be introduced pure water, reaching to the top of the upper tube, and there sealed close. When this compound tube was inverted in a basin of mercury, it is evident that the columns both of mercury and of water would sink, till their joint pressure became just equal to the superincumbent weight of the external atmosphere. But the variation of this weight would afterwards be indicated chiefly by the large motion of the water; since the mercurial column, spreading out above into a broad surface, must, in any case, experience a very slight difference of altitude. Thus, suppose the cylinder to have eight times the diameter of the upper tube, or a section sixty-four times greater, mercury being 13.6 times denser than water: for each inch of increase of altitude which the ordinary mercurial column gains, the top of the water would be raised in the tube 11.4 inches, its own rise being 11.18 inches, and that of the wide mercurial cylinder only .18 of an inch, yet equal in pressure to 2.4 inches of water. But Descartes, generally satisfied with mere theory and speculation, did not live to see his construction of the barometer carried into effect; and Chanut, the French resident at Stockholm, to whom he had imparted his views, met with such difficulty in the execution of the project, that, after some fruitless attempts, he abandoned it altogether.

Huygens was more fortunate, and succeeded, by dint of Huygens's perseverance and skill, in constructing the Cartesian double barometer. But he had the mortification to find that, in spite of all the pains he could take, the water, after it was relieved from the pressure of the atmosphere by the sealing up of the tube, constantly discharged a portion of air, which collected at the top, and by its elasticity depressed the compound column below its due altitude. Convinced that this source of imperfection is irremediable, he sought to rectify the construction of the instrument, and produced his *Double Barometer*; a form of combination frequently used, especially when the object is rather to make the variations very sensible than to obtain delicate results. (See fig. 5.) He joined a barometric tube of the usual length, by the flame of a blow-pipe, to two wide cylinders, the one sealed at the top, and the other annexed likewise hermetically to a tall and narrow tube, open at its extremity; he then bent the thicker tube a little above the lower cylinder, and brought the two branches to be parallel. The instrument being thus formed, he filled the first branch with mercury, and introduced above, in the second branch, some liquid of comparative lightness. Alcohol would, in this respect, answer extremely well, if it were not so lia-

Barometer. ble to waste by evaporation. An alkaline lye, or the deliquiate salt of tartar, which also readily admits of being coloured, was therefore, on the whole, preferred.

The principle of this construction is evidently the same as in that of Descartes; but the vacuum lying contiguous to the mercury itself, can have no admixture of disengaged air or of aqueous vapour. Since the cylinders are made very much wider than the bore of the annexed tube, the variation of pressure will be produced almost entirely by the change of altitude which the alkaline liquor undergoes, the mercury suffering only a very minute alteration of ascent or descent. The divisions of the ordinary scale will be about tenfold enlarged, if a section of each cylinder should exceed twenty times that of the tube in which the liquor plays.

Its advantages and defects.

A barometer of this construction has decided advantages with respect to the extent of its variations, but still it is not exempt from considerable defects. The moisture on the inner surface of the cylindrical reservoir increases the adhesion of the mercury, and retards its movements. But a much greater source of error proceeds from the influence of heat in extending the volume of liquor contained in that reservoir, and rising into the narrow stem. This instrument, therefore, to a certain extent, blends the indications of the barometer with those of the thermometer, which are essentially different, and can seldom accord.

Hooke's double barometer.

About the same period Dr Hooke likewise proposed a double barometer, of a similar construction. He afterwards resumed the subject, and with a view to correct the defect of the former arrangement, he produced, in 1685, an instrument of a more complex form, but very ingeniously conceived. (See fig. 6.) To the upper end of the open stem he joined a third cylinder of the same dimensions as the two former, but tapering away to a fine orifice at the top. The principal tube being filled as usual with mercury, extending to occupy the bottoms of both the connected cylinders, he introduced a liquor immediately over the mercury in the second cylinder, rising partly into the stem; above this, again, he poured another liquor specifically lighter and differently coloured, filling up the rest of the stem, and mounting into the third cylinder. By this artificial and delicate combination, the mercury is left perfectly stationary, and all the movements corresponding to the atmospheric pressure are performed by the counterpoising liquors, and marked by their line of mutual separation. Since the stem or narrow tube remains constantly full, the variation of its pressure must depend on the different proportions of its length occupied by the two fluids. If the weight of external atmosphere should, for instance, increase, the denser liquor will rise, and consequently cause the lighter liquor to contract its column. The action of this compound barometer, being thus produced merely by the difference of the gravity of the two fluids, might, therefore, be augmented indefinitely. Suppose the liquid resting on the mercury to be pure water, and the superincumbent liquid to be olive oil, which is about one twelfth part lighter; the scale would be enlarged no less than 163 times, or an alteration of one tenth in the altitude of the common mercurial column would be marked by a motion through 12×1.36 inches, or 16.3 inches. But such a vast enlargement of the scale is far greater than would ever be desirable in practice. It were better, therefore, to introduce next the mercury some fluid which is denser than water. If oil of sassafras were combined with oil of oranges, the divisions of the scale would be augmented only sixty-eight times, and consequently the whole range might not exceed ten or twelve feet. Those oils, however, would move rather sluggishly, especially in cold weather, and might, from their incessant shiftings, during a lengthened period, become insen-

sibly mixed. On the other hand, fluids of distinct characters are seldom free from chemical action; they expand differently with heat, and by coating with other traces the inside of the tube, they are the more apt to retard the motion of the column. In general, the advantage of any very great augmentation of the scale is counterbalanced, as the fluids then work by irregular starts; and the instrument loses in delicacy whatever it has gained in extent of action.

Another method of augmenting the variations of the wheel barometer was invented by the same fertile genius, which has the advantage of uniting great simplicity with tolerable accuracy. (See fig. 7.) Resuming the syphon barometer, he made a small float of iron or glass to rest on the exterior surface of the mercury, and suspended by a slender thread passed round a small wheel or cylindrical axis that carried an index. Though the varieties of the height of the mercurial column are, in a tube of this form, reduced to half the ordinary measure, yet, from the great length of the index compared with the diameter of its axis, the divisions on the circumference of the circle in which it travels are much amplified. The little machinery being concealed within the frame of the instrument, the index only is brought into view, protected by a circular plate of glass. Thus fitted up, the whole forms rather a handsome piece of furniture. The *Wheel Barometer*, as it is called, has long maintained its reputation among ordinary observers.

A very simple method of enlarging the divisions of the barometer is commonly ascribed to Sir Samuel Moreland, the same speculative adventurer who invented, or rather introduced from abroad, the *Speaking Trumpet*. (See fig. 8.) It consisted in merely bending the upper part of the tube into a very oblique position. By this deflexion, however, the scale which depends on the perpendicular altitude cannot be augmented beyond three or four times without incurring evident risk of inaccuracy. The instrument is called the *Inclined* or *Diagonal Barometer*. The form has been sometimes varied by the fancy of artists, who, repeating the inclination of the tube, have occasionally given the upper part a zig-zag appearance.

The most ingenious barometer, filled with mercury only, and yet admitting a scale of any extent, was invented by Cassini and by John Bernoulli, who first gave the description of it in 1710. (See fig. 9.) A wide cylinder is annexed to the top of the main tube, at the bottom of which there is joined at the right angles another long and narrow tube. The mercury, in ascending or descending within the wide cylinder, must, therefore, run along this horizontal tube. If that cylinder have a diameter only four times greater than the bore of the tube, the scale of variation will be augmented sixteen times. This instrument is, from its shape, called the *Square Barometer*. It is not found in practice to answer so well as the theory might lead us to suppose. The mercury creeps along the horizontal tube with difficulty, and by desultory advances; and these irregularities increase when, from its motion and exposure, it becomes covered with dust and partial oxidation.

The simplest of all the barometers with an enlarged scale, and at the same time one of the most ingenious, is the *Conical* or *Pendant Barometer*, invented and described in 1695 by Amontons, a French philosopher, who, being afflicted with total deafness in consequence of a fever in his infancy, had devoted himself to mechanical contrivances. (See fig. 3, Plate CVI.) This instrument consists merely of a tube, four feet or more in length, with a bore narrower than ordinary, and tapering regularly to the top. The width at the bottom must hardly exceed three twentieth parts of an inch, while near the

Barometer. top it may be contracted to about one tenth. A column of about thirty-one inches of mercury being introduced, the tube is gently inverted and held perpendicular; the cohesion of such a narrow column is sufficient to prevent it from dividing and admitting air unless it be shaken; but, overpowering the atmospheric pressure, it descends till it has contracted into the equiponderant altitude, by passing into a wider part of the tube. To obtain equal divisions on the scale, it is necessary that the tube should have a uniform taper. The most accurate construction of a barometer of this kind is, therefore, attained by joining together two tubes that have even but unequal bores, the longer and narrower one being uppermost. If the width of the upper tube were supposed to be to that of the under one as two to three, the scale would be enlarged three times, since, by descending three inches from the top, and consequently two at the bottom, the column would suffer a contraction of one inch in height.

This species of barometer is thus recommended by its simplicity and its ample range. But the bore of the tube being indispensably narrow, the mercury moves with difficulty, and resists the impression of minute changes of external action. When the conical-shaped tube is retained, the instrument is liable to some inaccuracy from the influence of the cohesion of the mercury, which varies with the diameter of the column in different parts of the tube.

Amontons likewise proposed another form of barometer, in which the mercurial column is subdivided among several short connected branches. (See fig. 10.) Suppose the instrument were to have only the third part of the usual height, the first, third, and fifth branches, enlarged above and below into very short cylinders, are filled with mercury; and the second, fourth, and sixth branches, which may have their bores narrower, are occupied with some light fluid, or simply with air. If the external pressure should suffer any diminution, the three mercurial columns which produce the counterpoise will each descend and push up the last fluid of the series by their combined effects. It is evident that, by multiplying those branches, the barometer will have its altitude proportionally reduced. But this construction, though specious in theory, is found to have no practical advantages. The instrument is, from its complication, very difficult to construct; its motions are sluggish, owing to the multiplicity of tubes and the conjunction of fluids, and they are subject to derangements from the variable influence of temperature. It has therefore been generally abandoned.

Sectoral
barometer. These different forms of the instrument have been variously modified, and often brought forward with claims of novelty. We may notice, however, the *Sectoral Barometer* proposed by Magellan, in which the mercury is always made to rise to the same high point of the tube, by drawing this less or more aside from the vertical position. The arc thus described will indicate the deviation from the perpendicular, and consequently the actual descent of the mercury. But the difference between the vertical and the oblique line is not measured by the inclination merely, it is proportioned to the versed sine of this angle, or nearly to the square of the arc. The advantage of this mode of observing is, therefore, best perceived in small variations of the mercurial column. In the hands of a skilful observer, the best and most accurate barometer, after all, is that of the original construction, with a tube rather wide, and a broad cistern. To apply minute divisions is decidedly preferable to any enlargement of the scale. The measuring of such divisions has been since rendered extremely easy by the adaptation of the differential scale; a most valuable contrivance, proposed by Vernier early in the seventeenth century, but strangely

neglected long afterwards. This delicate appendage being once adopted, it became the more desirable to improve the sensibility and regulate the correctness of the indications of the barometer.

The first object was carefully to cleanse the mercury, and to expel any portions of air or moisture adhering to the inside of the tube. The influence of aqueous vapour in depressing the mercurial column had been observed by Huygens; but other more evaporable fluids were afterwards found to occasion, by their presence, a still greater derangement. Homberg having, about the year 1705, washed a tube with alcohol to remove the impurities from its internal surface, remarked that the mercury introduced into it stood an inch and half lower than usual, a depression which this ingenious chemist was disposed to attribute to the elasticity of the spiritous exhalations collected above the mercurial column; though other academicians, and Amontons among the rest, misled by their Cartesian prejudices, sought to ascribe the effect to the different sized pores of the glass. These anomalies were removed by heating or rather boiling the mercury in the tube till it was completely purged of air and moisture, and brought into close contact with the inside of the tube. But a new fact occurred which long puzzled the mechanical philosophers. The tube of a barometer, which had been filled with more than usual care, was observed to exhibit a luminous appearance when moved or slightly agitated in the dark. This curious phenomenon gave occasion to multiplied and prolonged controversies; it was attributed to the subtle matter of Descartes, or ascribed to a native phosphorescence, or a latent fire inherent in the mercury. Our countryman Hauksbee, in the year 1708, gave the first rational explanation of the fact, by referring it to electricity, which he had just begun to cultivate as a distinct science. It resembles exactly, indeed, the experiment of the exhausted flask, in which an electrical current flashes with a diffuse lambent flame, like the *aurora borealis* or the *northern streamers*. The friction of the mercury against the inside of the tube excites electricity, while the vacuity, or rather the very attenuated vapour in which the supposed fluid plays, facilitates its expansion. When the vacuum is rendered very perfect by the careful and accurate boiling of the mercury, the lambent flashing ceases for want of a fine medium to conduct and disperse the electrical influence.

The next point to which experimenters were led to direct their attention, was the effect of the width of the tube on the altitude of the mercurial column. Plantade, a lawyer of Montpellier, appears to have been one of the first who remarked that the mercury stands always lower in narrow tubes. This fact he communicated about the year 1730 to Cassini, who was then occupied in the south of France with carrying on the great trigonometrical survey. But the discrepancies observed by Plantade, being unfortunately confounded with other collateral circumstances, were for a time overlooked. In tubes having a narrow bore, the depression of the mercury, however, is very considerable, as may be readily perceived in a small glass syphon, of which the one branch is about half an inch in diameter, and that of the other branch less than the tenth of an inch. Thus, if the narrow tube had a width of only the thirteenth part of an inch, the depression of the mercury would amount to half an inch, which is about the third part of the elevation to which water in similar circumstances would be raised by capillary action. This effect has not been sufficiently examined, but it appears to result from the attraction of the particles of the mercury to each other exceeding their attraction to the surface of the glass. Mercury, in contact with glass, therefore, tends to a spherical form, and always assumes a convex

Effect of moisture within the barometric tube.

Luminous barometer.

Effect of the width of the tube.

Barometer. surface within a clean tube. Water and other liquids, again, manifest an opposite character, the mutual attraction of their particles being less than their adhesion to glass. Accordingly, they spread along a vitreous surface, instead of collecting into drops; and in narrow tubes they mount above the level, and invariably have a concave termination. If the bore be so small as to be reckoned capillary, the depression of mercury is, like the elevation of water, inversely as the diameter; but when the bore has a considerable width, the quantity of depression, depending on the curvature of the surface of the mercury, diminishes proportionally faster, and follows nearly the inverse duplicate ratio of the diameter. But on the subject of capillary action we refer our readers with the utmost confidence to a valuable paper communicated to the Royal Society of London, by Mr Ivory, late of the Military College at Sandhurst, one of the most original and profound mathematicians that our island has had the honour to produce.

Pure mercury has always a convex surface.

The influence of the predominating attraction of the particles of mercury to themselves, above their adhesion to the sides of a glass tube, has not been considered with so much attention as it demands. Nothing is more common than to remark that the mercury in the barometer is in the act of rising if it show a convex surface, but about to fall if it should appear concave. Now, the top of the mercurial column must always remain convex if the barometer be properly constructed, the tube perfectly clean, and the mercury purged of all impurities. But if the inside of the tube be anywise soiled, whether covered with humidity or stained with mercurial oxyd, the metallic fluid will adhere so obstinately to the glass as to lose its convexity, and to subside into a flat surface, or even sink into a concavity, like water and other liquids. Hence the danger of boiling the mercury too long in the tube, as it becomes partially oxydated; and the thin crust so formed not only suspends the column higher, but obstructs the freedom of its motion. The same effect is produced by greasing the inside of the tube. Some respectable authors, from not attending to these facts, have hastily inferred that the convex appearance which mercury assumes in the barometer was merely accidental, and consequently removed by a more complete boiling and purification.

Quantity of depression in different tubes.

In the case of tubes having wide bores, the depression of the mercurial column may, without any sensible error, be disregarded. According to the accurate experiments made by Lord Charles Cavendish, and published by his son the celebrated Mr Cavendish, the quantity of depression is only the 200th part of an inch in a tube of 6-10ths of an inch in diameter, the 28th part of an inch in a tube of 3-10ths diameter, and the 15th part of an inch in a tube of 2-10ths diameter. Wide tubes ought, therefore, to be preferred in the construction of barometers, both on account of the facility with which the mercury moves in them, and the smallness of its depression. The only circumstance to overbalance these advantages would be the necessity and inconvenience of having a very large cistern. A quarter of an inch may be reckoned a good width of tube, and the corresponding depression is only the twentieth part of an inch.

Application of a leathern bag.

In the syphon barometer, if both branches have the same diameter, the action is exerted on opposite sides, and therefore the effect of depression becomes entirely lost. For accurate purposes, this original form of the instrument has been resumed, and the inconvenience arising from the large variation of the lower lever entirely obviated by an ingenious contrivance introduced above fifty years ago. This consists in the application of a leathern bag, instead of a wooden or ivory cistern, to hold the surplus mercury. Besides the barometric tube, there

is placed adjacent to it another short one of the same width, communicating with the mercury contained in the bag, which being pressed by turning a screw below, is at each observation brought exactly to the same mark. The external atmosphere readily acts through the substance of the leather; but the mercury, from the powerful cohesion of its own particles, cannot be squeezed through the pores of that casing without violent compression. The addition of a bag within a cylindrical box, omitting the lower tube, likewise renders the barometer easily portable; since, for safe carriage, the mercury can be screwed up tight, to fill the whole cavity of its tube, but, on turning the screw again, the column will subside and rest on a broad base.

The last object which required nice observation, was to estimate the effect of heat in dilating the mercury, and consequently increasing the altitude of the equiponderant column. This correction could not be made with any sort of accuracy previous to the application of the thermometer, which, though invented half a century earlier than the barometer, was yet more than another half-century in arriving at perfection. Hero, a mechanical philosopher, who flourished at Alexandria about 130 years before Christ, has described in his *Spiritualia* a sort of huge weather-glass, in which water was made to rise and fall by the vicissitudes of day and night, or rather the changes of heat and cold. This machine had for ages been overlooked, or merely considered in the light of a curious contrivance. But Sanctorio, the inventor of the famous statical balance, a very learned and ingenious Italian physician, who was long professor of medicine in the university of Padua, and had laboured to improve his art by the application of experimental science, reduced the hydraulic machine of Hero into a more compendious form, and thus constructed, about the close of the sixteenth century, the instrument since known by the name of the *air thermometer*, which he employed with obvious advantage to examine the heat of the human body in fevers. Some years afterwards a similar instrument was contrived, perhaps without any communication, by Drebbel, a very clever and scheming Dutch artist, who visited London in the reign of James I., and imported the knowledge of that instrument into England.

But this air thermometer was evidently of the same nature with what has been since called the *manometer*; it could measure only the dilatation or augmented elasticity of the air confined within its bulb, whether occasioned by heat or the diminution of external pressure. It was therefore considered merely as a weather-glass, indicating the state of the atmosphere; nor could its blended impressions, which might separately affect both the thermometer and barometer, be then distinguished. Had it been more closely studied, it must have led, by another path, to the discovery of the latter. But those irregularities to which the air thermometer was hence subject appear to have created such doubts respecting the accuracy of the instrument, as occasioned its being neglected long afterwards.

The same country, however, which had given birth to Florence the thermometer, began its improvement. After the principle of the barometer was established, the members of the Academy del Cimento, founded at Florence in 1657, and supplied with liberal funds by the grand duke of Tuscany, had, among other interesting physical researches, resumed the application of the thermometer; and, instead of air, they substituted alcohol or spirit of wine, another very expansible fluid not affected by atmospheric pressure, while they attached to the tube a scale graduated on a regular plan, though directed by no very precise measures. The instrument so constructed, but somewhat varied in its form, being copied by Italian ar-

Effect of heat on the barometer.
Invention of the thermometer.

Barometer. tists, was dispersed over Europe under the name of the *Florence Glass*. From its careless execution, however, in the hands of itinerant venders, this thermometer, or rather thermoscope, appears never to have obtained an established reputation.

Attempts to obtain a standard. The great object proposed was to bring thermometers to an exact correspondence. It was expedient, therefore, not only to select a proper fluid, but to adopt a uniform and consistent scale. Alcohol, linseed oil, and mercury, had been successively tried. The graduation was at first derived from the temperature of cellars and deep caves, which, indicating the natural heat of the globe, had long been considered invariable; but more enlarged experience discovered the inaccuracy of that supposition, and showed the mean temperature to be materially modified by the latitude of the place, and its elevation above the level of the sea. Congelation, or rather the inverted process, the thawing of ice, or the melting of snow, was then found to remain fixed; a most important fact, which had been first noticed by *Gürické*, but overlooked till a considerable time afterwards. A stationary point was hence obtained, from which to commence the thermometric scale. But different modes were pursued for determining the divisions.

Amontons. Amontons, reverting to the air thermometer in spite of its acknowledged defects, found that the elasticity of air compressed in the bulb, and able at the temperature of melting snow to support a column of mercury fifty-four inches high, was capable of raising this to seventy-eight inches at the heat of boiling water; and he seemed contented with framing a rude standard, by merely dividing the intermediate space into inches and half-inches.

Newton. But about the same, or nearly at the beginning of the eighteenth century, Newton himself cast a keen though rapid glance on the subject of heat, and proposed a thermometer of a much simpler and more elegant construction. Having adopted linseed oil as a fixed and uniform substance, capable of great dilatation, he discovered by experiment, that dividing the capacity of the bulb into ten thousand equal parts, the liquid expanded 256 parts from melting snow to blood-heat, and 725 parts to that of boiling water. These numbers, however, being inconveniently large, he reduced them somewhat more than twenty times, adopting 12 and 34 as the proportional divisions on his scale. But oil, being so viscid a substance, was found to trail and collect on the inside of the tube; and this thermometer, though constructed on a right principle, never came into general use.

Roemer. Roemer, the Danish astronomer who made the fine discovery of the progressive motion of light, was the first who proposed mercury as the fittest fluid for thermometers; and Halley and Amontons remarked about the same time, that it expands uniformly with heat, and remains nearly stationary at the point of boiling water. On this principle, Delisle of St Petersburg constructed, in 1733, a mercurial thermometer with a descending scale, the distance from freezing to boiling water occupying 153, or, in round numbers, 150 divisions, of which the bulb itself contains 10,000. A more ingenious method, but perhaps too refined, for graduating thermometers, was proposed

Renaldini. by Renaldini, a distinguished Italian mathematician, in 1694. It consisted in adopting the scale, in the successive temperatures produced by mixtures, in the different proportions of twelve parts of water at the moment of thawing and of ebullition. This suggestion led to a very important inference, since it proved that mercury expands uniformly with equal additions of heat, while alcohol swells constantly in a rising progression. But the capital improvement of the thermometer was effected by the skill and perseverance of Fahrenheit, whose name has remained justly attached to the instrument. This ingenious per-

son, originally a merchant at Dantzic, who had the misfortune to fail in business, was induced, by his taste for mechanics and chemistry, to have recourse to the manufacture of thermometers, as the means of gaining a slender livelihood. But not meeting with sufficient encouragement at home, he removed, about the year 1720, to Holland, the great emporium of the arts, and fixed his future residence at Amsterdam. He now preferred mercury to alcohol for filling his thermometers; and, adopting the division of the bulb into 10,000 parts, he reckoned sixty-four of them as the expansion between freezing and blood-heat, and thirty-two as the contraction from the same point to what he considered as extreme cold, or that produced by the mixture of one part of salt with three parts of snow. These numbers were extremely convenient, being found by a repeated bisection. With respect to the heat of boiling water, Fahrenheit discovered the important fact, that it varies with the state of atmospheric pressure. Taking the mean, however, he reckoned 180 degrees from freezing to ebullition, and therefore marked this point at 212 on his scale. The thermometer owes its improvement to Celsius, professor at Upsal, who in 1742 placed the commencement of the scale at congelation, and divided the interval thence to boiling water into an hundred degrees, extending such a portion downwards as might be wanted. This centesimal thermometer is exactly the same as what the French have since called the *centigrade*, which, from its fitness and simplicity, deserves to be universally adopted.

The thermometer having been thus carried by successive steps to perfection, it was found by delicate experiments, that, between the points of boiling and freezing, the expansion of mercury amounts to the fifty-fourth part of its bulk, or that it acquires, for each degree of heat, an increase of volume amounting to the 5412th part on the centesimal scale, or the 9742d part on the scale of Fahrenheit. A correction, therefore, on the height of the mercurial column in the barometer becomes necessary according to the changes of temperature which it undergoes. In this climate, the extreme variation arising from that cause will seldom exceed two tenths of an inch. But if the barometer be suspended in a room kept at an agreeable temperature, the error occasioned by the expansion of the mercury may, in ordinary cases, be disregarded, since it will scarcely amount to the twentieth part of an inch.

Since the barometer marks the condition of the distant atmosphere, and intimates those internal alterations which are generally connected with the change of the weather, it is particularly valuable at sea, by forewarning the mariner of the approach of a storm. But an instrument of the ordinary construction would not answer this purpose, the agitation of a vessel on a tempestuous ocean being such as would not only throw the ponderous mercurial column into violent oscillation, but communicate those sudden shocks which must infallibly break the tube. Various attempts have accordingly been made to obtain a *marine barometer* exempt from risk, and yet sufficiently sensible to the variations of the atmosphere. The conical or pendant barometer being, from the narrowness of its bore, rather sluggish, was first recommended for that purpose, though never adopted into practice. About the beginning of the eighteenth century, Dr Hooke and Amontons severally proposed to employ for a barometer on board ship, the manometer or air thermometer. To obviate the derangement arising from the influence of heat, there was to be placed beside it a spirit-of-wine thermometer, with a ball so large as to give expansions equal to those of the portion of air confined within the bulb. The difference between the two adjacent columns of liquid would there-

The Celsiusian or centigrade thermometer.

Correction of the barometer as affected by heat.

Marine barometer.

Barometer. fore measure the variation of external pressure. But to procure such a nice adaptation would prove so extremely difficult in practice, that most probably this instrument was seldom or never actually constructed. Besides, the liquid column of the manometer, though light and narrow, would yet be much shaken by the rolling and pitching at sea. Notwithstanding these weighty objections, however, this compound manometer was tried in England, mercury being employed as the fluid both of expansion and pressure, and various adjustments applied by means of a complex machinery.

Blondeau's marine barometer. An ingenious and very substantial kind of marine barometer was, above twenty years ago, recommended by Blondeau, one of the professors of the naval academy at Brest. (See fig. 11, Plate CVI.) It consisted of an iron tube, bent below into a syphon, and filled carefully with mercury, which carried a float. For this purpose, a musket-barrel, about three feet long, was chosen, having a very smooth and even bore, and an iron breech closely welded to it, instead of being soldered with brass, which might become corroded by the action of the mercury. The lower end of the tube had a collar of leather, to which was screwed a piece of iron, perforated through its whole length, and bent into an arch, having screwed likewise, with a collar of leather at its other extremity, a vertical cylinder of iron, four inches high, and of the same bore exactly as the tube. The contracted aperture at the end of the tube, not being exactly in the middle, was not always opposite that of the arch; and, therefore, by turning it occasionally aside, the communication could be contracted at pleasure, or even obstructed entirely. The cylindrical appendix was tapered at the top to a narrow orifice, through which an iron wire, attached to a small ivory float, had been introduced. To prepare this instrument for action, the mercury was first boiled in the tube; then the arch, filled with hot mercury, was screwed to the end, the cock opened, and the surplus mercury allowed to flow over; next the vertical piece, with its float, was screwed on, and a little mercury added, to give it due play. The origin of the scale was to be determined from the comparison with another good barometer of the ordinary construction; but, owing to the equality of the bores of the opposite tubes, the divisions were only half the usual size, or the inches were exhibited by half-inches. This species of barometer is certainly free from all sort of risk, while the facility which, by means of turning the arch, it affords in checking the ascent and descent of the mercury, prevents in a great measure the oscillations of that fluid. If the instrument were properly suspended, therefore, its indications would be tolerably steady and regular. The chief objection to it consists in the diminutive range of its scale.

In every marine barometer, the main object is to give steadiness to the mercurial column, by retarding its motion in the tube; in short, to imitate the equalizing effect of the fly in mechanics. One form of construction was, instead of the cistern below, to annex a spiral tube composed of a number of horizontal convolutions. Passemant, an ingenious Parisian artist, about the year 1758 improved on this idea. He twisted the barometer tube near the middle, at least twice round, and joined to its upper end a wide cylinder. But, more effectually to prevent all irregular oscillations, he took a tube with a very narrow or capillary bore, and contracted it below, while he annexed a wide cylindrical piece at its other extremity. The only thing wanted now to the perfection of this instrument, was to devise a mode of suspending it that should soften the jerks, and allow it generally to maintain a vertical position. Our English artists have, by repeated trials, at last succeeded in surmounting all the difficulties. The

marine barometer, manufactured by Mr Cary of London (see fig. 12, Plate CVI.), is one of the most approved kind. It consists of a capillary tube, about twenty-seven inches long, with a bore scarcely exceeding the thirtieth part of an inch, but terminated by a cylinder four or five inches high, and nearly three tenths of an inch in diameter. It is suspended by a spring and jimbols, near the top, at a certain point, which in each case is discovered by actual trial. By making the suspension lower, it is found that the agitation of the barometer will cause the mercury to rise a little; while, by placing the suspension higher, the mercurial column suffers always some depression. The reason of this curious observation is not well explained. It probably results from the different centrifugal tendencies communicated to the opposite portions of the columns. The swinging of the instrument would evidently augment the pressure of the upper portion of the column, while it diminished that of the under portion. But this lower portion being longer than the other, its tendency to descend would be proportionally so much greater. About the point of suspension, however, the opposite effects of the centrifugal tendencies are balanced, since the superior force being employed to set in motion a narrower column, the reflux and efflux of the mercury in the upper cylinder must be preserved nearly equal.

Marine barometers, thus improved, are now very generally used, and with great benefit to the public service, on board ships of war and Indiamen. To facilitate the keeping of a register of barometrical observations, the meritorious and indefatigable Mr Horsburgh, hydrographer to the East India Company, published a set of engraved ruled sheets, adapted for the convenience of navigators. In these plates the height of the mercury, from twenty-seven to thirty-one inches, is represented in inches and tenth parts by horizontal lines, while each successive day has a space apportioned to it by vertical bars. The state of the barometer at every observation is marked with a dot, and these dots being afterwards connected together, exhibit an irregular waved line, stretching across the sheet, and indicating the series of the changes of the weather. At the lowest points, from which the curve again returns, a gale generally follows. From the observations made off the Cape of Good Hope during the month of May 1815, by an ingenious and active officer, Captain Basil Hall, then of his majesty's sloop Victor, it appears that whenever the mercury fell to 29.60 inches, a storm ensued; the column always rose when the gale abated, and when it reached near thirty inches, the weather became fair. Those gales often came on suddenly, without any visible change in the aspect of the sky, but the marine barometer never failed to give warning of their approach.

A very convenient substitute for the marine barometer is the *sympesometer* constructed by Mr Adie, optician in Edinburgh. It is merely an improved *manometer*, partly filled with a fixed oil, and indicating the conjoined effect of heat and atmospheric pressure on the inclosed air; but the influence of temperature is corrected by means of a sliding scale, regulated by an attached mercurial thermometer. The *sympesometer* occupies little room, is easily rectified, and comparatively cheap.

To explain the cause of the variations of the barometer, has long perplexed philosophers. Many hypotheses have at different times been advanced on the subject; but it would be a mere waste of time to make any detailed recital of such crude and unsatisfactory attempts. The various and often imaginary effects of vapours, of heat, and of winds, have been employed in framing an explication of the changes of the atmosphere. The fact, that the mer-

Difficulty in explaining the variations of the barometer

Barometer. curial column generally falls before rain, seemed at complete variance with the intimation of the senses, a notion having become universally prevalent, that the air is heavier when the sky appears lowering and overcast; another proof, were it wanted, how fallacious are all current opinions in matters of science.

Leibnitz, fancying he had discovered a new principle in hydrostatics, endeavoured, by a sort of metaphysical argument, to demonstrate that, though a body adds its own weight to the pressure of a fluid in which it is suspended, yet it will cease to be ponderous during the act of falling. This alleged principle will not, in the actual state of science, be thought to require any serious refutation; nor, were it even admitted, would it be found at all adequate to the explication of the phenomenon, since the weight of moisture precipitated from the whole body of atmosphere could never, by the absence of its pressure, occasion a diminution of the tenth part of an inch in the altitude of the mercurial column.

Dr Halley and Mairan sought to account for the depression of the barometer before a storm, by the withdrawing of the vertical pressure of the atmosphere, when borne swiftly along the surface of the globe by a horizontal motion. This hypothesis at first sight appears very plausible, and might seem further confirmed by a noted experiment which most authors have admitted without due examination. Hauksbee, a skilful and ingenious experimental philosopher, about the year 1704 placed two barometers, about three feet asunder, with their naked cisterns in two close square wooden boxes, connected by a horizontal brass pipe; one of these boxes had, inserted at right angles, an open pipe on the one side, and a second pipe, terminating in a screw, on the other side; to this end he adapted a strong globular receiver of about a foot in diameter, which had been charged, by injection from a syringe, with three or four atmospheres; then suddenly opening the stop-cock, and giving vent for the escape of the air through the box and over the surface of the included cistern, the mercury sunk equally more than two inches in both the barometers.

Hauks-
bee's ex-
periment.

Its fallacy.

This elegant experiment might be deemed entirely conclusive, if a minute circumstance, on which the success really depends, had not unfortunately been overlooked. It will be perceived from the inspection of the figure which Hauksbee has given, that the exit pipe of the box was considerably wider than the pipe which conveyed into it the stream of air. This fluid, escaping from compression, would therefore be carried by its elasticity as much beyond the state of equilibrium; while the width of the orifice, by facilitating its emission, would allow the portion occupying the box and the connected reservoir to preserve its acquired expansion. If the pipe of discharge from the box had been much narrower than the other, an opposite effect must have taken place; for the air accumulated over the cistern, not finding a ready vent, would remain in a state of condensation. This curious fact is another of the many instances which might be cited to show the great delicacy and circumspection required in performing philosophical experiments.

Similar results, however, can be exhibited by a very simple apparatus. Let a small box, or rather a glass ball, have a short narrow tube inserted in the one side, and

another wide tube opposite to this, with a cross slider of brass, for contracting the orifice at pleasure; and, to the under part of the ball, join a long perpendicular tube, bent back like a syphon to more than half its height, and containing a double column of water. Now, blow through the narrow tube into the cavity of the ball, while the orifice of emission is quite opened, and the liquid will rise several inches in the long stem; but, still continuing the blast, let the orifice be gradually contracted, and the column will first descend to its ordinary level, and then sink considerably below it.

The fall and rise of the mercury in the barometer must evidently be occasioned by some corresponding reduction or accumulation of the atmosphere at the place of observation. Whatever augments the elasticity of the air will cause part of the incumbent fluid to evade and leave for the time a diminished vertical pressure. The efflux of wind might also produce a temporary reduction of the atmospheric column. But the real difficulty consists in explaining why the variations of the barometer should be greater in the high latitudes than between the tropics, and why they so much exceed in all cases the quantities which calculation might assign.

Causes of
the varia-
tion of the
barometer.

The influence of heat will account for the semi-diurnal variations of the barometer which are observed, especially within the torrid regions. From ten o'clock in the morning till four in the afternoon, the mercury generally falls; but, after that hour, it rises again, till ten o'clock at night, when it drops till four in the morning, and then mounts till ten o'clock in the forenoon. These regular changes, which amount to about the five hundredth part of the whole atmospheric pressure, depend on the prevalence of the alternating land and sea breezes, occasioned by the diversified action of the sun's rays upon the earth and water. The accumulation of air is greatest at four o'clock in the morning and evening, and the mercury then attains its highest point; but it sinks lowest at ten o'clock in the morning and evening, when the incumbent mass has been the most reduced.

A similar reason will explain the effects of the northerly and easterly winds, in elevating the mercury of the barometer in our climate. A chill air, with enfeebled elasticity, is thus accumulated and exerts a predominant pressure.

The augmented elasticity communicated to the air by the action of heat or the presence of humidity, and the reduction of the incumbent mass by the efflux of winds, have each their distinct influence in disturbing the equilibrium of the atmospheric ocean. But the effects, particularly in the high latitudes, much surpass the regular operation of those causes. The only mode, perhaps, of removing the difficulty, is to take into consideration the comparative slowness with which any force is propagated through the vast body of atmosphere. An inequality may continue to accumulate in one spot, before the counterbalancing influence of the distant portions of the aerial fluid can arrive to modify the result. In the higher latitudes, the narrow circle of air may be considered as, in some measure, insulated from the expanded ocean of atmosphere, and hence, perhaps, the variations of the barometer are concentrated there, and swelled beyond the due proportion. See the articles CLIMATE and METEOROLOGY. (B.)

BAROMETRICAL MEASUREMENTS.

Barometrical Measurements.

It was remarked in the preceding article, that the decisive experiment by which Pascal established the reality of atmospheric pressure, had likewise suggested to this ingenious philosopher the method of determining the elevations of distant points on the surface of the globe. But the first attempts were very rude, proceeding on the inaccurate supposition that the lower mass of air is a fluid of uniform density. Different authors estimated variously from eighty to ninety feet as the altitude, which corresponds to a variation of the tenth part of an inch in the mercurial column. The Torricellian tube or cane, as it was then called, was, on its first introduction to England, carried accordingly to the tops of mountains, or conveyed to the bottom of pits and mines, or even let down to great depths in the sea.

Sinclair.

Among those experimentalists who laboured most assiduously in the study and application of the barometer in this part of the island, we may mention George Sinclair. This ingenious person had been professor of philosophy in the university of Glasgow, but seems to have conscientiously resigned his office soon after the Restoration, rather than comply with that hated episcopacy which the minions of Charles II. had forced upon the people of Scotland. He then retired to the village of Tranent, not far from Edinburgh, and was employed as a practical engineer, in tracing the levels of coal-pits, in directing the machinery employed in the mines at Leadhills, and afterwards in the great undertaking of conducting water from the heights of the Pentlands to supply the northern metropolis. Though not a profound mathematician, he was skilled in mechanics and hydrostatics, and possessed no small share of invention. Sinclair is said to have been the first who applied to the mercurial tube the name of *baroscope*, or *indicator of weight*; the more definite appellation of *barometer*, or *measurer of weight*, not having been appropriated till many years afterwards. During his excursions in 1668 and 1670, he employed that instrument to measure the heights of Arthur's Seat, Leadhills, and Tinto, above the adjacent plains. He followed the original mode of using a tube sealed at the top, with a paper scale pasted against the side, which he carried to the top of the mountain, where he filled it with mercury; and, inverting it in a basin, he noted the altitude of the suspended column, and repeated the same experiment below; a very rude method, certainly, but no better was practised in England during the succeeding thirty years.

In a small scarce tract, printed in 1688, and bearing the quaint title of *Proteus bound with Chains*, Sinclair gives some judicious remarks on the variations of the barometer,

considered as a weather-glass, and delivers very sound opinions, on the whole, respecting the causes of the chief meteorological phenomena. In a postscript to that piece, he proposes a most efficient and ingenious method of weighing up wrecks from the bottom of the sea. It consisted in employing two large arks, or square wooden boxes, fastened to the sides of the ship, and charged with air carried down to them by a succession of inverted casks, open at the lower end. An arc of a cubical shape, and twenty feet in every dimension, the smallest which he mentions, would, as he computes, have a buoyancy equivalent to 448,000 pounds Troy. It is remarkable that the celebrated Mr Watt always employed this very mode, using a large gazometer, floating in a pond dug in the court of his manufactory, and charged gradually by the action of bellows, for raising the ponderous engines constructed at Soho, and lifting them over his walls into the boats, which were stationed to receive them in the adjacent canal.¹

In all the computations hitherto made from different altitudes of the barometer, the air was considered as a uniform fluid; no regard being had to the gradual diminution of density which must evidently take place in ascending the atmosphere. To estimate the effect of that gradation, it became requisite previously to determine the actual relation subsisting between the density of the fluid and its elasticity. This was first ascertained in England by Townley, who inferred, from some experiments of Boyle, that the elastic force which the air exerts is exactly proportional to its density. A similar conclusion was about the same time drawn by Mariotte, a French philosopher, from a still better series of experiments. Following out this very simple law, he thought of computing heights from barometrical observations, by the rules usually employed in constructing tables of logarithms; and had, therefore, obtained some glimpse, no doubt by a sort of conjectural process, of the remarkable result, that the density of the atmosphere decreases in a geometrical progression, corresponding to the elevations taken after an arithmetical one. But seemingly not aware of the importance of the principle at which he was pointing, Mariotte immediately deserted it; and calculating from a repeated bisection of the column of air between the two stations into successive horizontal strata, he contented himself with interpolating the densities according to a harmonic division, which he next abandoned for the simplicity of a series with equal differences. This able experimenter hence only sketched out a mode of investigating the problem of barometrical measurements, without arriving at any very definite or consistent rule of solution.

Barometrical Measurements.

Relation of the air's density and elasticity.

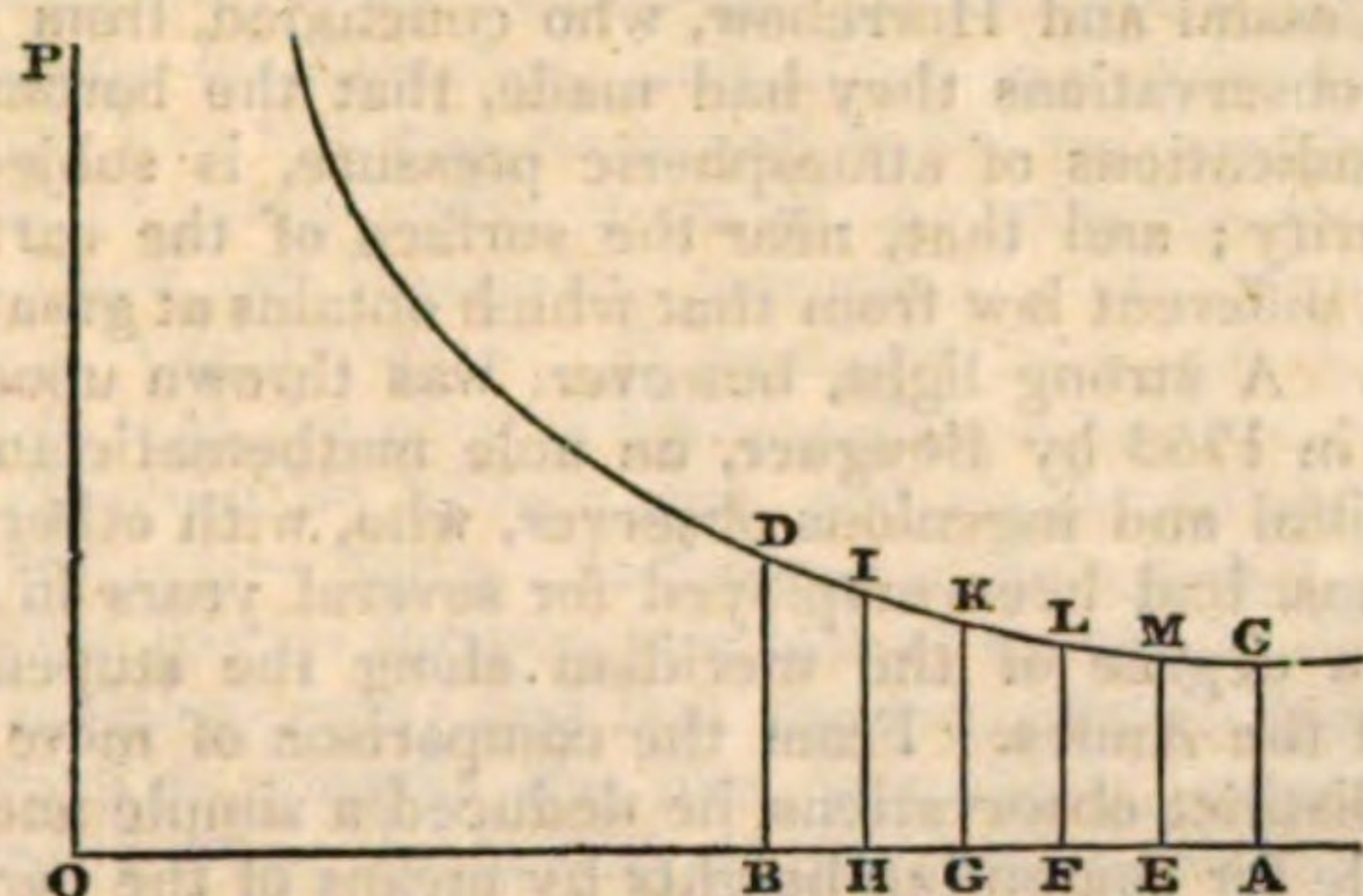
¹ Sinclair was author of a well-known little book entitled *Satan's Invisible World Displayed*, which, at a former period, was sold at all the public fairs in the country, and devoured with eagerness and dismay by the Scottish peasantry. In a quarto volume, on *Hydrostatics, and the Working of Coal-mines*, printed in Holland, and published by subscription in 1672, he digressed so widely from his subject as to insert *A True Relation of the Witches of Glenluce*. But this was the folly of the age, from which several of the most learned men had not been able to escape. It is painful to observe, that James Gregory, the inventor of the reflecting telescope, who, although endowed with talents of the highest order, appears to have had a keen temper, and to have imbibed an hereditary attachment to royalism and episcopacy, should have stooped to attack an unoffending and less fortunate rival. He wrote a little tract against Sinclair's *Hydrostatics*, with the title of the *Art of Weighing Vanity*, and under the thin disguise of Patrick Mather, arch-beadle to the university of St Andrew's. It is a piece full of low scurrility, and memorable only for a very short Latin paper appended to it, containing the series first given to represent the motion of a pendulum in a circular arc. In the British Museum, there is a letter of Gregory to Collins, the secretary of the Royal Society, boasting of his project, and soliciting information with which to overwhelm the poor author. But with all his eagerness to hunt down Sinclair, he never touches on the strange episode of the Witches of Glenluce. What a picture of times approaching so near to our own! Sinclair was restored to his chair at the Revolution, and lived a few years longer. He answered Gregory's attack in the same coarse style, charging him with total want of skill in the use of astronomical instruments, though by help of subscriptions he had erected a sort of observatory at St Andrew's. The manuscript of this reply is preserved in the College Library of Glasgow.

Barometrical Measurements.

Relation of atmospheric density and elevation.

Barometrical Measurements.

In 1686 that ingenious and active philosopher Dr Halley resumed the subject, and discovered the law that connects the elevation of the atmosphere with its density; of which he gave a clear demonstration, derived from the well-known properties of the hyperbola referred to its asymptotes.¹ Since the height of the mercury indicates the pressure, and consequently the elasticity of the external air, it must be proportioned likewise to the density. Wherefore the breadth of a given mass of air, or the thickness of a stratum which corresponds to a certain portion of the mercurial column, will be inversely as this altitude. Let O be the centre of a rectangular hyperbola, of which OA and OP are the asymptotes; and conceive the distances OA and OB to represent the heights of the mercury at two stations. The perpendiculars AC and BD, which are reciprocally as OA and OB, must hence express the relative thickness of strata corresponding to equal por-



tions of the barometric scale. Divide AB into a multitude of equal segments, and erect the perpendiculars EM, FL, GK, and HI. The intercluded spaces, from AC to BD, will denote the successive thickness of the series of strata into which the whole mass of air between the two stations is subdivided. Consequently the aggregate or mixtilineal space DBAC, which is proportional to the logarithm of the ratio of OB to OA, will express the difference of atmospheric elevation when the mercurial column mounts from B to A. Taking equal ascents, therefore, in the atmosphere, the corresponding densities must, from the property of the hyperbola, form a decreasing geometrical series.

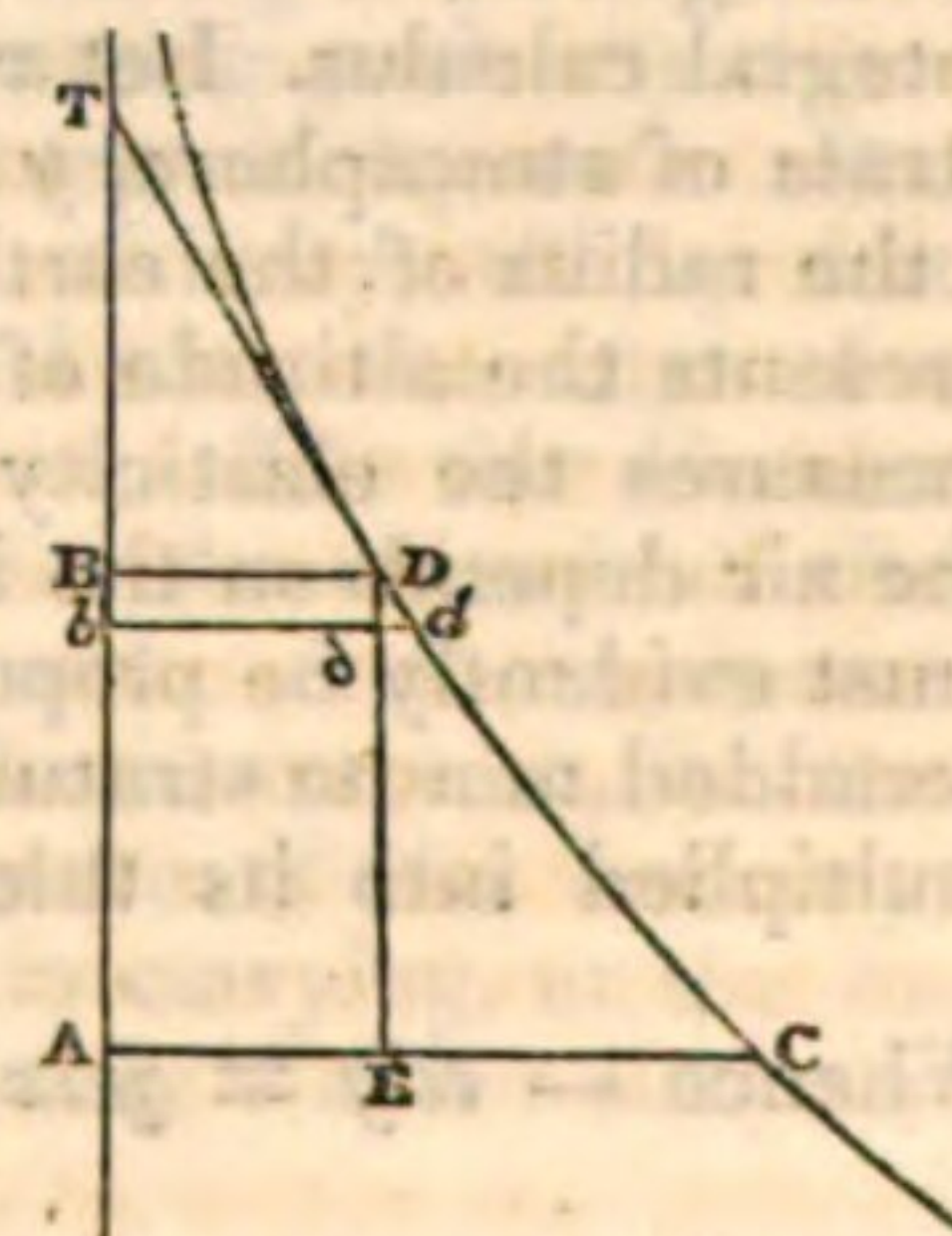
Rule deduced.

To apply this elegant theorem, Dr Halley availed himself of the best experiments which had been performed to determine the relative densities of air, water, and mercury. In different trials made near the earth's surface, it was found, when the barometer stood at $29\frac{3}{4}$ inches, that the air is 840, 852, or even 860 times lighter than water. Employing round numbers, therefore, and assuming the specific gravity of mercury to be $13\frac{1}{2}$, he reckoned $800 \times 13\frac{1}{2} \times 30 = 10,800$ inches, or 90 feet, as the altitude of an atmospheric column which, near the level of the sea, would exert a pressure equivalent to that of an inch of mercury. For the co-efficient, which answers to the actual constitution of the atmosphere, Halley should have taken the thirtieth part of .4342945, the modulus of the common system of logarithms, or .0144748. But he proceeded less directly, having satisfied himself with taking the

arithmetical mean between the differences of the logarithms of 29 and 30, and of those of 30 and 31; a compensation of errors which gives .0144765, hardly deviating from the former. Hence he gave this simple analogy for computing the heights of mountains by the barometer: *As the constant number .0144765 is to the difference between the logarithms of the barometric columns at the two stations, so is 900 feet to the elevation required.* The result of this operation is evidently the same as if the logarithmic difference had been multiplied by the number 62170; a very tolerable approximation at all seasons for a northern climate, and quite accurate, indeed, if the mass of intervening air had a medium temperature of 46° by Fahrenheit's scale. Dr Halley supposed that the observations themselves might, from the influence of heat, differ about a fifteenth part between summer and winter. But the thermometer was still so imperfect an instrument, that it could not be applied with confidence in correcting such variations.

The principle which Halley thus investigated might be derived from a simpler process. Conceive the atmosphere to be divided into a multitude of equally thin horizontal layers, it is evident that each successive stratum would, to the pressure of the superincumbent stratum, add its own weight, which being as its density or elasticity, is therefore proportioned to the collective pressure; and, consequently, those densities must continually increase in going downwards, exactly in the same way, and after a like progression, as money accumulates at compound interest, where a constant portion of the aggregate fund is regularly joined to the capital.² Such, in fact, is the distinguishing character of a geometrical progression, that the increase or decrease of each succeeding term is always proportional to the term itself. The logarithmic curve is hence the best adapted for exhibiting the relations which connect the densities with the elevations in the atmosphere; the axis of the curve expressing the elevation, while each ordinate represents the corresponding density of the stratum of air. It being a fundamental property of the logarithmic curve, that every subtangent applied to it has the same length, the exact determination of this in the case of our atmosphere is the only thing wanted for the final solution of the general problem.

Let AB, the absciss of a logarithmic curve, represent a line descending perpendicular through the atmosphere; the ordinates AC and BD will indicate the elasticity of the strata at A and B, and consequently, abating the influence of temperature, their densities. Draw the tangent DT, and form the elemental triangle Ddδ; then $BD : BT :: \delta d : \delta D$, or inversely $BD : \delta d :: BT : \delta D$. But the thickness δD of each accrescent stratum being assumed to be the same, and the subtangent being constant, from the nature of the curve; the ratio of BT to δD is given; therefore the ratio of BD to δd is likewise given, or the increment of the density in the successive strata is proportional to



¹ It appears, however, that he was anticipated by Huygens, who had found, as early as the year 1662, that the altitudes of successive strata of air being taken in arithmetical progression, the corresponding densities will form a geometrical series. This beautiful proposition he never published, indeed, but left it recorded upon one of the blank leaves of a Dutch almanac, containing various other speculations, and now preserved in the library of the university of Leyden.

² To illustrate still further this comparison; if we reckon the mean altitude of a uniform atmosphere to be 26000 feet, it will follow that, for every descent of 26 feet, the density of the air will increase one thousandth part. This rate of progression corresponds precisely with the weekly improvement of money invested at 5 per cent. per annum, supposing, for the sake of simplicity, the year to contain only 50 weeks. Since money at the statute interest doubles in $14\frac{1}{2}$ years, so the air has its dilatation doubled at the height of $26 \times 50 \times 14.2$ or 18466 feet, answering to three miles and a half.

Barometrical
Measurements.

the density itself, the leading property of air. The pressure of the thin stratum at B is represented by $BDdb$, which is equal to the rectangle under BT and dd . Hence, drawing the parallel DE, the collective area ABDC, which represents the weight of the atmosphere between the altitudes A and B, is equal to the rectangle under the subtangent and EC. But AB expresses the difference of the logarithms of the ordinates AC and BD, or the densities at A and B; and consequently this difference multiplied by the length of BT will indicate AB. In relation to our atmosphere at the point of congelation, the numerical value of the subtangent is about 26,000 feet, which is very nearly the product of 60,000 into the *modulus* of the ordinary logarithms.

Eleven years after Dr Halley had given his rule for barometrical measurements, this philosopher had an opportunity of applying it to discover the height of Snowdon in North Wales. He found that the barometer which stood at 29.9 inches on the sea-shore near Caernarvon, fell a few hours after, when planted on the summit of the mountain, to 26.1 inches, the altitude having been ascertained previously, by a trigonometrical observation, to be 1240 yards.

Newton's
general so-
lution.

The year 1687 is memorable as being the date of the first publication of the *Principia*, which was drawn up chiefly at the urgent request of Halley, from disjointed materials that had lain a considerable time in the author's closet. In that immortal work, Newton resumed the problem of the gradation of atmospheric density, and solved it in that general way which suited his penetrating genius. He demonstrated that, supposing the particles of air, like other bodies, to have their weight or gravitating tendency diminished as the squares of their distances from the centre of the earth, if those distances be taken in harmonic progression, the corresponding densities of the atmosphere will form a geometrical one. But since the diminution of attraction at the greatest height we are able to reach amounts only to the two thousandth part of the whole, this difference is too minute to be adopted in practice; and the simpler law first established by the sagacity of Halley may be deemed sufficiently accurate for every real purpose.

Newton has given a sort of geometrical solution of the problem. But a more precise, and, in this case, a clearer investigation, is obtained by help of the symbols of the integral calculus. Let x and x' express the altitudes of two strata of atmosphere, y and y' the corresponding densities, r the radius of the earth; and suppose further, that e represents the altitude of the equiponderant column which measures the elasticity of the air. Since the density of the air depends on the incumbent pressure, its decrement must evidently be proportional to the weight of each superadded minute stratum, or to the density of this stratum multiplied into its thickness and power of gravitation.

Whence — $edy = ydx \left(\frac{r}{r+x} \right)^2$, or — $\frac{edy}{y} = \frac{r^2 dx}{(r+x)^2}$,

of which the complete integral is $e \text{ Hyp. Log. } \frac{y'}{y} = \frac{r^2}{r+x}$

— $\frac{r^2}{r+x} = \frac{r^2}{r+x} \cdot \frac{x' - x}{r+x}$. If r be regarded as indefinitely great in comparison of x , the expression will pass into $e \text{ Hyp. Log. } \frac{y'}{y} = x' - x$, which is only the common formula.

Applica-
tion of the
thermome-
ter.

Little seemed wanting, therefore, to complete the practice of barometrical measurements, but the application of the thermometer to correct the results. This instrument, however, advanced slowly to perfection, and more than

forty years yet elapsed before it came into current use. Some of the continental philosophers likewise, biassed, perhaps, by a secret jealousy of the superiority which England had acquired in science, began to throw out doubts respecting the reality or accuracy of the law of geometrical progression in the atmosphere. Daniel Bernoulli, a man of candour on the whole, as well as ingenuity, but who, with some proneness to speculative reasoning, had unfortunately imbibed many of the prejudices of the Cartesian and Leibnitzian schools, proposed in his capital work, the *Hydrodynamica*, which appeared in 1736, some vague hypotheses regarding the constitution of the atmosphere, as deduced from certain internal motions attributed to its component strata. The specious results of those calculations led him hastily to deviate from the principle of the geometrical progression of density in the upper regions. In this departure from nice theory he was followed by Cassini and Horrebow, who concluded, from some partial observations they had made, that the barometer, in its indications of atmospheric pressure, is subject to irregularity; and that, near the surface of the earth, it obeys a different law from that which obtains at great elevations. A strong light, however, was thrown upon the subject in 1753 by Bouguer, an able mathematician and very skilful and ingenious observer, who, with other academicians, had been employed for several years in measuring a degree of the meridian along the stupendous ridge of the Andes. From the comparison of more than thirty distinct observations, he deduced a simple and elegant rule for computing heights by means of the barometer. It is this, that the difference between the logarithms of the mercurial columns at the two stations being *diminished* by one thirtieth part, and the decimal point shifted four places to the right, will express the required elevation in *toises*. Since the English was to the French foot nearly as fifteen to sixteen, the rule would be accommodated to our measures, and the result expressed in feet, if the logarithmic difference were *augmented* by the thirtieth part, then multiplied by six, and the decimal point thrown back four places; or, which is the same thing, if that logarithmic difference were multiplied at once by 62,000. But Bouguer imagined, that this rule would not hold exactly in Europe, or in the lower regions of the torrid zone; and to explain the deviation, he had recourse to the forced supposition that the particles of air possess different degrees of elasticity. Lambert, a philosopher of great originality and penetration, afterwards published some excellent remarks on the comparison of barometrical measurements. But no material progress was made till 1755, when M. de Luc of Geneva resumed the subject, and carefully combined experiment with observation. For the space of fifteen years and upwards, he prosecuted his inquiries with diligence and perseverance, aided by the peculiar advantages of local situation, in a city abounding with skilful artists, and seated in the neighbourhood of lofty mountains. The discrepancies which had hitherto created so much embarrassment proceeded mostly from the inattention of observers to the disturbing influence of heat, and particularly its effect in expanding the air, and consequently augmenting the elevation due to a given difference of atmospheric pressure. De Luc's first object was to improve the thermometer of Reaumur, which, though greatly inferior to that of Fahrenheit, had been adopted in France and the adjacent parts of the Continent. Having ascertained that mercury has the valuable property of expanding equably with equal additions of heat, he substituted that metallic fluid for spirit of wine, but retained its arbitrary and inconvenient scale of eighty degrees between the points of freezing and boiling water. He next examined the dilatation of air

Barometrical
Measurements.

Bouguer.

De Luc.

Barometrical Measurements.

Barometrical Measurements.

Shuckburgh, and Roy.

Formula of Laplace.

at different temperatures, and corrected those results by numerous observations made on the mountains of Savoy, and the mines of the Hartz, in which the barometer was combined with the thermometer. The formula which he thence deduced for the computation of barometrical measurements was, in 1772, published in his *Recherches sur les Modifications de l'Atmosphère*, and seemed to attract, especially in England, a very considerable degree of notice. Dr Maskelyne, the astronomer-royal, adapted it to our system of measures, and De Horsley made annotations and comments on it. But, what was of more importance, other accurate observers, incited by De Luc's example, entered the same field of inquiry, provided with instruments of greater delicacy and much better construction. In 1775 Sir George Shuckburgh Evelyn visited the Alps, and combined trigonometrical operations with corresponding observations by barometers and thermometers from the hands of Ramsden; and about this time likewise, General Roy not only measured, with instruments made by that excellent artist, some of the principal mountains in Scotland and Wales, but instituted a series of manometrical experiments. It resulted from all these researches that, for each degree on Fahrenheit's scale, mercury expands the 9700th part, and air the 435th part of their respective bulks. It further appeared that the atmosphere has its temperature almost uniformly diminished at equal ascents; and that the logarithmic difference, reckoning as integers the first four digits, expresses in English fathoms the height of an aerial column as cold as the point of congelation. General Roy proposed likewise another correction depending on the enfeebled gravity, and consequently the augmented altitude, of the equiponderant column of atmosphere in the lower latitudes, occasioned by the influence of centrifugal force arising from the earth's rotation. Several years afterwards, Professor Playfair, in a learned paper, printed in the first volume of the *Transactions of the Royal Society of Edinburgh*, examined all the circumstances which can affect barometrical measurements, and discussed each question with the correctness and perspicuity that we might expect from his distinguished abilities. At nearly an equal interval of time the celebrated Laplace resumed the subject in his *Mécanique Céleste*, and brought all the conditions together in a very complicated formula. Such an appearance of extreme accuracy, however, is perhaps to be regarded merely as a theoretical illusion, unsuited and inapplicable to any real state of practice. Biot has since attempted to arrive at a similar conclusion, by setting out *à priori* from some careful experiments on the relative density of air and mercury, performed by him in conjunction with Arago. He thence infers that, in the latitude of Paris, and at the point of congelation, air, under a mercurial pressure of 76 metres, or 29,922 English inches, is 10,463 times lighter than mercury at the temperature of water at its lowest contraction. This would give 26,090 feet for the height of a column of homogeneous fluid, whose pressure is equivalent to the elasticity of the atmosphere. The co-efficient adapted to common logarithms, and adjusted to the force of attraction at the level of the sea, would therefore be 60,148 feet, or 18,334 metres; scarcely differing sensibly from the quantity which Ramond had deduced from a very numerous set of experiments made by him on the Pyrenees. But Biot prefers, as the co-efficient, the number 18,393, answering for an elevation of 1200 metres, or about 4000 feet above the sea, which is not far from the general level of such observations. The formula is hence, in English feet,

$$\left(1 + \frac{2(T+t)}{1000}\right) \log. \frac{H}{h};$$

where ψ denotes the latitude of the place, T and t the temperatures of the air at the two stations, as indicated by the centesimal thermometer, and H and h the heights of mercurial columns corrected for the effects of heat.

This active writer has likewise given tables for expediting the calculation of barometrical measurements; in which he was anticipated, however, by Oltmans of Berlin, who published, in 1809, large *Hypsometrical Tables*, as they are called, accommodated to the complex formula of Laplace. Such tables might no doubt prove useful where very frequent computations are wanted, as in the case of the reduction of the numerous observations brought home by Baron Humboldt, for which, indeed, they were first designed. But still they contain a needless profusion of figures, and hold forth a show of extreme accuracy which the nature of the observations themselves can never justify. The mere calculation of barometrical measurements is a secondary object. The great difficulty is to procure good observations, and to combine tolerable accuracy with expedition. For this purpose, a very portable barometer is still wanted;—an instrument light and commodious, exempt from injury or derangement, and yet sensible to minute changes of atmospheric pressure. These properties, indeed, are seldom conjoined, and one advantage must generally be sacrificed to obtain another. A modification of the conical barometer already suggested would seem, on the whole, to be well adapted for the geological traveller. The two unequal tubes are cemented into a small cylinder of steel, with a fine stop-cock of the same metal confining the mercury. This renders the instrument so portable that it may be inclosed in a walking-stick; on turning the steel-cock, and inverting the staff, the height of the mercurial column is readily found.

A barometer of the most improved construction is represented in fig. 19; a portion of the tube is shown in fig. 20; and a section of its cistern in fig. 21. By help of a screw pressing against the bottom of a leathern bag, inclosed within a cylindrical ivory box, the mercury is always brought up through a tubular aperture to the same precise level; or till its convex surface appears to touch a very thin line of light, which is admitted through a slip of ivory applied against the side of the chink or separation of this tube from a wider one immediately over it. The lower end of the mercurial column being thus adjusted, the length is easily measured by drawing gradually down a hollow brass tube, divided at intervals by wide slits, covered on one side by thin bits of ivory, till by that softened light a contact is observed with the edge of a slit and the convex top of the column. The fine Vernier which the movable tube carries gives the altitude of the mercury in thousandth parts of an inch. A thermometer is likewise constantly attached to the instrument, for the purpose of indicating the temperature of the mercury, which, from the heat of the hand in carrying, or the influence of the solar beams, is commonly warmer than the external air.

This mountain barometer is suspended for observation by jimbols from a tripod, as exhibited in fig. 18; but its several parts can be folded up together into a convenient compass, tolerably well fitted for carriage, as represented in fig. 19. The whole apparatus may not exceed the weight of ten pounds; yet even this, moderate as it might seem, would be felt a serious encumbrance by a traveller who is engaged, day after day, in the labour of climbing mountains. The risk which the instrument incurs, besides, in transporting it perhaps over rough precipices, imposes a perpetual constraint, while to make correct observations with it must always require time and patient attention. A lighter and more compact, though less accurate, barometer will generally be preferred by the geo-

Mountain barometer.

Barometrical
Measurements.

Portable
barometer
of Sir H.
Englefield,

and of Gay-
Lussac.

Modified
conical barometer.

logical traveller, whose object is rather to extend our acquaintance with the altitudes of mountains, than to aim at a superfluous and often illusory precision. The portable instrument, invented by Sir Henry Englefield, and represented in fig. 14, will, on the whole, answer those views. Its cistern is formed of box-wood, sufficiently tight to hold the mercury, without preventing the access and impression of the external air. When this barometer is inverted, the mercury, therefore, subsides very slowly in the tube, which must be firmly suspended in a vertical position. For greater security, the mercury is now put into a leathern bag introduced within the cistern.

A very simple and convenient sort of portable barometer was lately invented in France by that celebrated chemical philosopher M. Gay-Lussac. (See fig. 15 and 16.) It consists of rather a wide syphon tube, filled with mercury, and sealed hermetically at the inverted end, having a very fine capillary hole formed about an inch under this, by nicely directing the flame of a blow-pipe against the side of the glass, and drawing a melted spot of it out to a point. The lower portion of the principal branch has its bore contracted to less than the tenth part of an inch, to prevent the mercurial column from dividing in the act of inverting it. The mercury is boiled as usual, and the tube may be concealed in a walking-stick, or lodged, like the complete mountain barometer, in a cylinder of brass, with movable sliders bearing the divisions of a Vernier at both ends. (See fig. 17.) For greater simplicity, however, the larger divisions might be engraved on the tube itself. This kind of barometer is of ready use, and very little exposed to hazard in carriage. It is commonly held in a reclined or inverted position; but, in making an observation, it must be gently turned back, and kept perpendicular till the mercury descends through the contracted bore, and slowly rises again in the opposite short branch; the scale is noticed at both ends of the incurved column, and the difference of those indications gives its correct altitude.

A modification of the conical barometer, which, in travelling, we have ourselves employed with great ease and advantage, should likewise be mentioned. The principal part of it consists of a small stop-cock made of steel, and represented in fig. 13. A glass tube of 31 or 32 inches long, with a bore of the tenth part of an inch hermetically sealed at the top, and filled with quicksilver, is cemented into the one end of the stop-cock; and into the other end is cemented an open and wider tube, 16 inches or more in length, and having its diameter above the eighth part of an inch. This compound tube is lodged in a walking-stick, divided into inches and tenths through its whole extent, or only at the upper part, if uniform tubes be selected. In making an observation, the cock is turned, and the instrument inverted. The upper column then descends partly into the lower tube, till it becomes shortened to the proper altitude.

We have already stated the principles on which the calculation of barometrical measurements proceeds. But there still are some points, either assumed or overlooked, which may considerably modify the results. It is presumed, that, at equal successive heights, the temperature of the atmosphere decreases uniformly. This property, however, does not hold strictly, and it may be shown, from a comparison of the best observations, that the decrements of heat follow a quicker progression in the higher regions. But we shall soon have another opportunity to examine this subject, and trace out its various consequences.

The humidity of the air also materially affects its elasticity, and the hygrometer should therefore be conjoined with the thermometer in correcting barometrical observations. But nothing satisfactory has yet been done in re-

gard to that subject. The ordinary hygrometers, or rather hygroscopes, are mere toys, and their application to science is altogether hypothetical. A most unphilosophical course has lately been pursued, by multiplying calculations grounded on very loose data, instead of instituting a nice and elaborate train of original experiments.

In the actual state of physical science, it is preposterous, therefore, to affect any high refinement in the formula for computing barometrical measurements. The whole operation may be reduced to a very short and easy process. But the simplicity of the calculation would be still greater, if the centesimal thermometer were generally adopted. It will be sufficiently accurate, till better data are obtained, to assume the expansion of mercury by heat as equal to the 5000th part of its bulk for every centesimal degree, while that of air is twenty times greater, being an expansion for each degree of the 250th part of the bulk of this fluid. 1. *Correct the length of the mercurial column at the upper station, adding to it the product of its multiplication into twice the difference between the degrees on the attached thermometers, the decimal point being shifted four places to the left.* 2. *Subtract the logarithm of this corrected length from that of the lower column, multiply by six, and move the decimal point four places to the right; the result is the approximate elevation expressed in English feet.* 3. *Correct this approximate elevation by shifting the decimal point three places back to the right, and multiplying by twice the sum of the degrees on the detached thermometers; this product being now added, will give the true elevation.*

If it were judged worth while to make any allowance for the effect of centrifugal force, this will be easily done before the last multiplication takes place, by adding to twice the degrees on the detached thermometers the fifth part of the mean temperature corresponding to the latitude. The mean temperature itself is formed by multiplying the square of the cosine of the latitude by twenty-nine.

In illustration of these rules, we shall subjoin some real examples. General Roy, in the month of August 1775, observed the barometer on Caernarvon Quay, at 30.091 inches, the attached centesimal thermometer indicating 15°.7, and the detached 15°.6; while, on the peak of Snowdon, the barometer fell to 26.409 inches, and the attached and detached thermometers marked respectively 10°.0 and 8°.8. Here twice the difference of the attached thermometers is 11°.4, and twice the sum of the detached thermometers is 48°.8, which becomes 50.8 when augmented by the fifth part of the mean temperature on that parallel. Now, omitting the lower decimals, the first correction is $.00264 \times 11.4 = .030$, to be added to 26.409. Wherefore,

$$\text{Log. } 30.091 = 1.4784866$$

$$\text{Log. } 26.439 = 1.4223450$$

$$\text{Difference} = .0561416$$

$$\text{Constant multiplier} = 60000$$

$$\text{Approximate height} = 3368.496$$

And, for the true height, the correction is $3.37 \times 50.8 = 171.2$, which gives 3340 for the final result.

We shall take another example from the observations made by Sir George Shuckburgh Evelyn, at the same period, among the mountains of Savoy. This accurate philosopher found the barometer, placed in a cabin near the base of the Mole, and only 672 feet above the surface of the lake of Geneva, to stand at 28.152 inches, while the attached and detached thermometers indicated 16°.3 and 17°.4; but, in another barometer carried to the summit of that lofty insulated mountain, the mercury sunk to 24.176 inches, the attached and detached thermometers marking 14°.4 and 13°.4. Wherefore, twice the difference

Barometrical
Measurements.

Rule for
computing
barometrical
measurements.

Examples.

Barometrical Measurements.

Barometrical Measurements.

of the degrees on the attached was $3^{\circ}8$, and twice the sum of the degrees on the detached thermometers was $61^{\circ}6$. Consequently the correction to be applied to the higher column was $\cdot 0024 \times 3 \cdot 8 = \cdot 009$, which makes it $4 \cdot 185$. Now,

$$\begin{aligned} \text{Log. } 28 \cdot 152 &= 1 \cdot 4495092 \\ \text{Log. } 24 \cdot 185 &= 1 \cdot 3835461 \\ \text{Difference} &= \cdot 0659631 \\ \text{Constant multiplier} &= 60000 \end{aligned}$$

$$\text{Approximate elevation} = 3957 \cdot 786$$

To correct this approximate elevation, remove the decimal point three places back, and multiply it by $61^{\circ}6$, increased by $2^{\circ}9$, the fifth part of the mean temperature, corresponding to the latitude; but $3 \cdot 96 \times 64 \cdot 5 = 255 \cdot 4$, and $3957 \cdot 8 + 255 \cdot 4 = 4213$. Hence the summit of the Mole is 4885 feet above the lake of Geneva, or 6083 feet above the level of the Mediterranean Sea.

The last example we shall give is drawn from the observation which Baron Humboldt made among the Andes, near the summit of Chimborazo, the highest spot ever approached by man. This celebrated traveller found there, that the barometer fell to 14·850 English inches; the attached thermometer in the tent being at 10° , and the detached in open air being $1^{\circ}6$ under zero. But the same barometer, carried down to the shore of the Pacific Ocean, rose exactly to thirty inches, while both the attached and detached thermometers stood at $25^{\circ}3$. Consequently the correction to be applied to the upper column is $= \cdot 0015 \times 30 \cdot 6 = \cdot 045$. Wherefore,

$$\begin{aligned} \text{Log. } 30 \cdot 000 &= 1 \cdot 4771213 \\ \text{Log. } 14 \cdot 895 &= 1 \cdot 1730405 \\ \text{Difference} &= \cdot 3040808 \\ \text{Constant multiplier} &= 60000 \end{aligned}$$

$$\text{Approximate elevation} = 18244 \cdot 848$$

Now, the difference of the detached thermometers, or $26^{\circ}9$, being doubled and further increased by $5^{\circ}8$, the fifth part of the mean temperature at the equator, makes $59^{\circ}6$; and the final correction to be applied is therefore $= 18 \cdot 24 \times 59^{\circ}6 = 1087$, which gives 19,332 feet for the true elevation observed, or 2140 feet below the summit of Chimborazo.

Calculation without logarithms.

These calculations are performed by the help of logarithms. It is desirable, however, to approximate at least to barometrical measurements without such aid. A very simple rule for this object has been given by Professor

Leslie in his *Elements of Geometry*. Since $\log. \frac{a}{b} = 2 M$

$\left(\frac{a-b}{a+b} + \frac{1}{3} \left(\frac{a-b}{a+b} \right)^3 + \frac{1}{5} \left(\frac{a-b}{a+b} \right)^5 \&c. \right)$, where M denotes the modulus of the logarithmic system; when a approaches to b , the lower terms may be rejected without sensible error, or $\log. \frac{a}{b} = 2 M \left(\frac{a-b}{a+b} \right)$, very nearly.

Wherefore, in reference to our atmosphere, the modulus is expressed by the equiponderant column of homogeneous fluid, or $60,000 \times \cdot 4342945 = 26,058$ feet, or only 26,000 in round numbers; whence, as the sum of the mercurial columns is to their difference, so is the constant number 52,000 feet to the approximate height. Let General Roy's observation on Snowdon be resumed as an example: the analogy is $30 \cdot 091 + 26 \cdot 439 : 30 \cdot 091 - 26 \cdot 439$, or $56 \cdot 530 : 3 \cdot 652 :: 52,000 : 3,359$, the approximate elevation, differing very little from the logarithmic result.

This mode of calculation may be deemed sufficiently accurate for determining any altitude that exceeds not 5000 feet. But it will extend to greater elevations if the

second term of the series be likewise taken, which is done by striking off three figures, and cubing the half of this number. Thus, resuming the mensuration of Chimborazo, $44 \cdot 895 : 15 \cdot 105 :: 52,000 : 17,496$, and $(8 \cdot 75)^3 = 670$, making together 18,166 for a nearer approximation.

The calculation of barometrical measurements, including the corrections required, is rendered most easy and expeditious by means of a sliding rule made by Mr Cary, optician in London. This small instrument should always go along with mountain barometers; and it will be found a very agreeable companion to every geological traveller.

But portable barometers, in spite of every precaution, are yet so liable to be broken or deranged, that other auxiliary methods are desirable for ascertaining distant elevations. In this view, the variation of the boiling point of water was proposed by Fahrenheit as far back as the year 1724; the idea having occurred to him, as it had done before to Amontons, while engaged with experiments to perfect his thermometer. Little regard, however, seems to have been paid to the suggestion till De Luc and Saussure made a series of observations on the heat of ebullition at different elevations above the surface. About thirty years since, Cavallo attempted to revive the scheme of Fahrenheit, but experienced much difficulty in preventing the irregular starts of the thermometer plunged in boiling water. The best and surest way of examining the heat of ebullition, is to suspend the bulb of the thermometer in the confined steam as it rises from the water.

The heat at which water boils, or passes into the form of steam, depends on the weight of the superincumbent atmosphere. By diminishing this pressure, the point of ebullition is always lowered. It appears that, while the boiling heat sinks by equal differences, the corresponding atmospheric pressure decreases exactly, or at least extremely nearly, in a geometrical progression, it being found that every time such pressure is reduced to one half, the temperature of boiling water suffers a regular diminution of about eighteen centesimal degrees. This beautiful relation assimilates with the law which connects the density and elevation of the successive strata of the atmosphere. The interval noticed between the boiling points at two distinct stations must be proportional to their difference of altitude above the level of the sea. We have, therefore, only to determine the co-efficient or constant multiplier, which may be discovered either from an experiment under the rarefied receiver of an air-pump, or from an actual observation performed at the bottom and on the top of some lofty mountain. We shall prefer at present the observation made by Saussure on the summit of Mont Blanc. This diligent philosopher found, by means of a very delicate thermometer constructed on purpose, that water which boiled at $101^{\circ}62$ in the plain below when the barometer stood at 30·534 English inches, boiled at $86^{\circ}24$ on the top of that mountain, while the barometer had sunk to 17·136. Wherefore the distance between the points of ebullition, or $15 \cdot 38$ centesimal degrees, must correspond to an approximate elevation of 15,050 feet, which gives $978 \frac{1}{2}$ feet of ascent for each degree, supposing the mean temperature of the atmospheric column to be that of congelation. But it will be more convenient to assume 1000 for the constant multiplier, which corresponds to the temperature of $5 \frac{1}{2}^{\circ}$.

To reduce this very simple result into practice, it would be requisite to have a thermometer with a fine capillary bore, and nicely constructed, the stem six or eight inches long, and bearing ten or a few more degrees from the boiling point; these degrees to be divided into twenty or perhaps fifty equal parts engraved on the tube, which should be rather thick, and terminating in a bulb of about half an inch diameter. This thermometer, being fitted

Barometric scale.

Tempera-
ture of
boiling wa-
ter applied
to the
mensura-
tion of
heights.

Barometrical
Measurements
||
Baron.

Barometrical
Measurements
||
Baron.

Mode of
tracing
vertical
sections.

with a brass ring two inches above the bulb, should screw into the narrow neck of a small copper flask, which holds some water, but has a hole perforated near the top for allowing the steam to escape. The water may be made to boil by the application of a lamp. The difference between the indications of the thermometers at the two stations being multiplied by a thousand feet, will give the elevation corresponding to a temperature of $5\frac{1}{2}^{\circ}$. The correction for the actual mean temperature can easily be applied. If a more correct co-efficient be afterwards determined, the same thousand, retained as a multiplier, may easily be adapted to another temperature.

This method of measuring elevations on the surface of the globe is, therefore, capable of great improvement, and might be employed with advantage in a variety of cases where observations with the barometer are not easily obtained. Its application would be most important to physical geography, in ascertaining the capital points for tracing the outline of the profile or vertical section of any country. The common maps, which exhibit mere superficial extension, are quite insufficient to represent the great features of nature, since the climate and productions of any place depend as much on its elevation above the sea as its latitude. Scientific travellers have accordingly turned their attention of late years to the framing of vertical sections. As a specimen, we give, in fig. 22, from Humboldt's *Geography of Plants*, a section across the American continent, one of the best and most interesting that has yet appeared. It consists, in fact, of four combined sections, traversing through an extent of 425 miles. The line begins at Acapulco, on the shore of the Pacific Ocean, and runs 195 miles, about a point of the compass towards the east of north, to the city of Mexico; then 80 miles, a point to the south of east, to La Puebla de los Angeles; again it holds a north-east direction of 70 miles, to the Cruz Blanca; and finally bends 80 miles east by south, to Vera Cruz, on the coast of the Atlantic. A scale of altitudes is annexed, which shows the vast elevation of the table-land of Mexico. An attempt is likewise made in this profile to give some idea of the geological structure of the external crust. *Limestone* is represented by straight lines slightly inclined from the horizontal position; *Basalt*, by straight lines slightly reclined

from the perpendicular; *Porphyry*, by waved lines somewhat reclined; *Granite*, by confused hatches; *Amygdaloid*, by confused points.

By this mode of distant levelling, a very interesting discovery, in another quarter of our globe, was made by Engelhardt and Parrot, two Prussian travellers. They proceeded, on the 13th July 1814, from the mouth of the Kuban, at the island of Taman, on the Black Sea; and, examining carefully every day the state of the barometer, they advanced with fifty-one observations, the distance of 990 wersts, or 711 English miles, to the mouth of the Terek, on the margin of the Caspian Sea. Similar observations were repeated and multiplied on their return. From a diligent comparison of the whole, it follows that the Caspian is 334 English feet below the level of the Black Sea. That the Caspian really occupies a lower level than the Ocean, had been suspected before, from a comparison of some registers of barometers kept at St Petersburg, and on the borders of that inland sea; but the last observation places the question beyond all doubt. It further appears, that within 250 wersts, or 189 miles, of the Caspian, the country is already depressed to the level of the Ocean, leaving, therefore, an immense basin, from which the waters are supposed to have retired by a subterranean percolation.

If the same plan of barometrical measurements had been followed by the adventurous explorers of the African continent, and the altitudes of the central lakes ascertained, the question regarding the course of the Niger would have been much sooner settled, and much vague and unsatisfactory discussion avoided. Even thermometrical observations of the temperature of springs, or of the ground at moderate depths, would have furnished an approximation to those elevations sufficiently near for solving that great problem in geography on scientific principles alone.

The spirit of modern enterprise has more lately carried barometers to the remotest and loftiest stations on the surface of our globe. It has been thus ascertained that some of the mountains in the equatorial parts of America attain the stupendous altitude of 25,000 feet, while the great chain of Upper India seems to rear its vast summit about 2000 feet still higher. See CLIMATE, HYGROMETRY, and METEOROLOGY. (B.)

BARON, a person who holds a barony. The origin and primary import of this term have been much contested. Menage derives it from the Latin *baro*, a word which we find used for *vir*, a "stout" or "valiant man;" whence it was that those placed next the king in battles were, according to him, called *barones*, as being the bravest men in the army; and as princes frequently rewarded with fees the bravery and fidelity of those about them, the word came to signify any noble person who held a fee immediately of the king. Isidore, and after him Camden, suppose the word, in its original acceptation, to have meant a "mercenary soldier;" and Messieurs de Port Royal derive it from *βαρος*, "weight" or "authority." But Cicero uses the word *baro* for a stupid brutal man; the old Germans make mention of "buffeting a baron," meaning a villain; and the Italians use the word *barone* to signify a "beggar." M. de Marca thinks baron derived from the German *bar*, "man," or "freeman;" others seek its origin in the old Gaulish, Celtic, and Hebrew languages; and some are of opinion that it comes from the Spanish *varo*, a "stout noble person;" whence wives used to call their husbands, and princes their tenants, "barons." In the Salic law, as well as in the laws of the Lombards, the

word *baron* signifies *man* in general; and, accordingly, the old glossary of Philomenes renders baron *avng*, "man."

BARON is more particularly used amongst us for a lord or peer of the lowest class, or a degree of nobility next below that of viscount, and above that of knight or baronet. In ancient records the word *baron* included all the nobility of England, because all noblemen were barons even although they occupied a higher rank in the peerage. But anciently it sometimes happened, that, when a baron had been raised to a new degree of peerage, the two titles, in the course of a few generations, descended differently, one perhaps to the male descendants, and the other to the heirs-general, by which means the earldom or other superior title subsisted without a barony; and there are also modern instances where persons have been created earls and viscounts without annexing a barony to their other honours; so that now the rule does not hold universally, that all peers are barons.

The origin and comparative antiquity of barons have been the subject of much research amongst English antiquaries. But the most probable opinion is, that they were the same with our present lords of manors; to which the appellation of *court-baron*, which is the lord's court,

Barons.

and incident to every manor, seems to give countenance. The original name of this dignity in England is said to have been *vavassour*, which by the Saxons was changed into *thane*, and by the Normans into *baron*. From Magna Charta it appears that originally all lords of manors, or barons, had seats in the great council or parliament; but such is the defective state of the public records, that the first precept to be found is not of older date than the 49th of Henry III.; and this, though it had been issued out in the king's name, had neither his authority nor his sanction, since not only the king himself, but his son Prince Edward, and most of the nobility who remained faithful to him, were then prisoners in the hands of the rebellious barons; having been taken at the battle of Lewes, in the month of May preceding, and detained in captivity until the memorable battle of Evesham, which happened in August the year following.

Before the 49th of Henry III., the ancient parliaments consisted of archbishops, bishops, abbots, earls, and barons. Of these barons there were two sorts; the greater barons, or the king's chief tenants, who held *in capite* of the crown; and the lesser barons, who held of the greater by the tenure of military service. The former had a summons to parliament by several writs; and the latter, if possessed of thirteen knights' fees and a quarter, had a general summons from the sheriff in each county. Matters continued in this state until the 49th of Henry III., when, instead of keeping to the old form, the prevailing powers thought fit to summon only those of the greater barons who were of their party, and, in room of the lesser barons who attended with large retinues, to issue their precepts to the sheriffs of counties to cause two knights in every shire to be chosen, and one or two burgesses for each borough, to represent the people residing in those counties and boroughs;—an innovation which gave rise to the separation into two houses of parliament. Hence the title came by degrees to be confined to the greater barons, or lords of parliament; and, among the peerage, no other barons were admitted except such as had been summoned by writ, in respect of the tenure of their lands or baronies, until Richard II. converted it into a mere title of honour, by conferring it on divers persons by his letters patent.

When a baron is called up to the house of peers by writ of summons, the writ is in the king's name, and he is directed to repair to the parliament appointed to be holden at a certain time and place, and there to treat and advise with his majesty, the prelates, and nobility, about the weighty affairs of the nation. The ceremony of the admission of a baron into the house of peers is this: He is brought into the house between two barons, who conduct him up to the lord chancellor, his patent or writ of summons being carried by a king-at-arms, and presented by him kneeling to the lord chancellor, who reads it, then congratulates him on his becoming a member of the house of peers, and invests him with his parliamentary robe. Thereafter the patent is delivered to the clerk of parliament, and the oaths are administered to the new peer, who is then conducted to his seat on the barons' bench. The coronation robes of a baron are the same as those of an earl, except that he has only two rows of spots on each shoulder; and, in like manner, his parliamentary robes have but two guards of white fur, with rows of gold lace; but, in other respects, they are the same as those of other peers. King Charles II. granted a coronet to the barons, having six pearls set at equal distances on the chaplet. A baron's cap is the same as a viscount's. His style is *Right Honourable*; and he is addressed by the king or queen, *Right Trusty and Well Beloved*.

BARONS by ancient tenure were those who held certain territories of the king, who still reserved the tenure in

chief to himself. There were also *barons by temporal tenure*, who held their honours, castles, and manors, as heads of their barony; that is, by grand serjeantry, by which tenure they were anciently summoned to parliament. But at present a baron by tenure is not a lord of parliament till he be called thither by writ.

BARONS of the Exchequer, four judges to whom the administration of justice is committed in causes betwixt the king and his subjects relative to matters of revenue. Their office is also to look into the accounts of the king, for which reason they have auditors under them.

BARONS of the Cinque-ports are members of the house of commons, elected by the five ports, two for each port.

BARON and Feme, in the *English Law*, a term used for husband and wife, in relation to each other, who are deemed but one person; so that a wife cannot be witness for or against her husband, nor he for or against his wife, except in cases of high treason.

BARON and Feme, in *Heraldry*, is when the coats of arms of a man and his wife are borne per pale in the same escutcheon; the man's being always on the dexter side, and the woman's on the sinister. But in this case the woman is supposed not to be an heiress, for then her coat must be borne by the husband on an escutcheon of pretence.

BARON, ROBERT, a dramatic author, who lived during the reign of Charles I. and the protectorship of Oliver Cromwell. He received the earlier part of his education at Cambridge, after which he became a member of Gray's Inn. During his residence at the university he wrote a novel called the *Cyprian Academy*, in which he introduced the first two of the dramatic pieces mentioned below. The third of them is a much more regular and perfect play, and was probably written when the author had attained a riper age. The names of these productions are, 1. *Deorum Dona*, a masque; 2. *Gripus and Hegio*, a pastoral; and 3. *Mirza*, a tragedy. Mr Baron had a great intimacy with Howell the traveller, in whose collection of Letters there is one addressed to this gentleman, who was then resident at Paris.

BARONET, a dignity or degree of honour next below that of baron, and above that of knight, with precedence of all knights excepting those of the Garter, and the only knighthood that is hereditary.

The dignity of baronet is generally conferred by patent, and forms the lowest degree of honour that is hereditary. The order was instituted by King James I. at the suggestion of Sir Robert Cotton in 1611, when two hundred baronets were created at once, being the number to which it was intended they should always be restricted; but it is now enlarged at the king's pleasure, without limitation. Originally, the creation of this order seems to have been merely an expedient to raise money in the name of fees, which, in each case, amounted to about L.1200 sterling.

Baronets take precedence according to the dates of their patents, conformably to the terms of which, no intermediate honour between barons and baronets can be established. The title or prefix of *Sir* is granted them by a peculiar clause in their patents, though they be not dubbed knights.

BARONETS of Scotland, called also *Baronets of Nova Scotia*. This order of knights baronets was instituted by Charles I. in the year 1625, when the first person dignified with the title was Sir Robert Gordon of Gordonstone, a younger son of the earl of Sutherland. The object of the institution was to encourage the plantation and settlement of Nova Scotia in North America: hence the king granted to each of them a certain portion of land in this province, which they were to hold of Sir William Alexander, afterwards earl of Stirling, with precedence to

Barons

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Baronets.

Baronets
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Baronius.

them and their heirs-male for ever, before all knights called *equites aurati*, all lesser barons called *lairds*, and all other gentlemen, except Sir William Alexander, his majesty's lieutenant in Nova Scotia, his heirs, their wives and children. It was further provided that the title of *Sir* should be prefixed to their Christian name, and Baronet added to their surname; and that their own and their eldest sons' wives should enjoy the title of *Lady, Madam*, or *Dame*.

Mr Malone has given the following curious note upon this subject, in his very learned *Life of Dryden*, prefixed to his edition of the prose works of that writer:—"When the order of baronets was first established in 1611, King James engaged that they should not exceed two hundred. However, towards the close of his reign, that number being completed, and the creation of baronets being found a useful engine of government (the courtier by whose influence the title was obtained receiving usually L.1000 for the grant), it was not lightly to be parted with. A scheme, therefore, of creating *Baronets of Scotland* was devised, which, it was conceived, would be no infraction of the original compact, to confine the grants to a limited number; and as the English baronets were created under the great seal of England, for the reduction of Ulster in Ireland, so the Scottish baronets were created under the great seal of Scotland, for the reduction of Acadia, or *Nova Scotia*. The scheme, however, was not carried into execution by King James; but early in the reign of his successor several Scottish baronets were made. From this statement it appears, that there is no more necessity for calling a baronet created under the great seal of Scotland (whether he be an Englishman or Scotchman), a *Baronet of Nova Scotia*, than there is to denominate one created under the great seal of England a *Baronet of Ulster*." (Malone's *Dryden*, vol. i. p. 28-9.)

BARONETS of Ireland. This order was likewise instituted by King James I. in the 18th year of his reign, for the same purpose and with the same privileges within the kingdom of Ireland as had been conferred on the analogous order in England; for which also the Irish baronets paid the same fees into the treasury of Ireland.

BARONI, LEONORA, a celebrated singer and composer, was born at Naples, but spent the greater part of her life at Rome. She was daughter of Adriana Baroni of Mantua, baroness of Piancetta, a lady also distinguished for her musical talents, and, on account of her beauty, surnamed the Fair. Leonora, like her mother, was celebrated by the wits, who vied with one another in their eulogiums of the fair *cantatrice*; and, in 1639, there was published, at Bracciano, a collection of Latin, Greek, Italian, Spanish, and French poems addressed to her, under the title of *Applausi Poetici alle Glorie della Signora Leonora Baroni*. Among the Latin poems of Milton are no fewer than three, entitled *Ad Leonoram Romæ Canentem*, in which this lady is celebrated for her vocal powers, with an allusion to her mother's exquisite performance on the lute. A discourse on the music of the Italians, printed with the life of Malherbe, and some other treatises, at Paris, 1672, in 12mo, contains an elaborate and somewhat high-flown eulogium on the musical talents of this accomplished lady. It was composed by M. Maugars, prior of St Peter de Mac, the king's interpreter of the English language, and so famous as a performer on the viol, that the king of Spain and several other sovereign princes of Europe desired to hear him.

BARONIUS, CÆSAR, a pious and learned cardinal, was born at Sore in 1538. He studied at Rome, and put himself under the discipline of Philip de Neri. In 1593 he was made general of the congregation of the Oratory by the resignation of the founder Philip de Neri. Pope

Clement VIII. made him his confessor, and raised him to the rank of cardinal in 1596. He was afterwards made librarian to the Vatican, and died in 1605, at the age of sixty-eight. He wrote several works, the principal of which is his *Annales Ecclesiastici* from A. D. 1 to 1198, in 12 vols. folio; a work which has been abridged by several persons, particularly by Henry Spondæus, Bzovius, and Ludovico Aurelio.

BARONY, BARONIA, or *Baronagium*, the lordship or fee of a baron, either temporal or spiritual. Baronies, in their first creation, proceeded from the king himself, the chief lord of the whole realm, and could be holden immediately of no other lord. For example, the king enfeoffed a man of a great seigniorship in land, to be held by the person enfeoffed and his heirs, of the king and his heirs, by baronial service; that is, by the service of twenty, forty, sixty, or such other number of knights, either more or fewer, as the king by his enfeoffment limited or appointed. In the ages immediately succeeding the Conquest, when a great lord was enfeoffed by the king of a large seigniorship, such seigniorship was called a *barony*, but more commonly an *honour*; as, the honour of Gloucestershire, the honour of Wallingford, the honour of Lancaster, the honour of Richmond, and the like. But there were in England certain honours which were often called by Norman or other foreign designations; that is to say, sometimes by English and sometimes by foreign names. This happened when the same person was lord of an honour in Normandy, or some other foreign country, and also of an honour in England. For example, William de Forz, de Force, or de Fortibus, was lord of the honour of Albemarle in Normandy, and also of two honours in England, namely, the honour of Holderness, and that of Skipton in Craven; and these honours in England were sometimes called by the Norman name, as the honour of Albemarle, or the honour of the earl of Albemarle.

BARRA, or **BARRAY**, island of. See **BARRAY**.

BARRA, in *Commerce*, a long measure used in Portugal and some parts of Spain, to measure woollen cloths, linen cloths, and serges. There are three sorts of barras; that of Valencia, thirteen of which make 12½ yards English measure; that of Castile, seven of which make 6½ yards; and that of Aragon, three of which make 2½ yards English.

BARRABA, DESERT of, a tract of land in Siberia, lying between the rivers Irtisch and Obi, in the province of Tobolsk. It is uninhabited, but not owing to any defect of the soil, which is excellent for tillage, and part of it might also be laid out in meadows and pastures. It is interspersed with a great number of lakes, abounding with a species of carp called by the neighbouring people *karaw-schen*; and the country produces great numbers of elks, deer, foxes, ermines, and squirrels. Between the Irtisch and Obi are some rich copper mines, particularly on a mountain called Pictowa, from the *picta* or white firs that grow upon it. Every hundredweight of the ore found here yields twelve pounds of pure copper; and there is no occasion for digging deep in order to come at it. Most of these ores, besides being very rich in copper, yield a considerable portion of silver; and this, again, affords as much gold as makes a sufficient return for the trouble and expense of extracting it.

BARRACAN, in *Commerce*, a sort of stuff, not diapered, something like camlet, but of a coarser grain. It is used to make cloaks, surtouts, and such other garments. The cities where barracans are chiefly made in France are Valenciennes, Lisle, Abbeville, Amiens, and Rouen; but those of Valenciennes are the most valued.

BARRACKPORE, a town of Hindostan, in the province of Bengal, about sixteen miles above Calcutta.

Barony
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Barrack-
pore.

Barracks. BARRACKS, called by the French *Casernes*, places for soldiers to lodge in, especially in garrisons. Till the middle of the year 1792, when there was a prospect of war with revolutionary France, and the British ministry became apprehensive of disturbances in this country, barracks were not numerous, nor were they under the control and management of a separate and peculiar board. Previous to this they were built under the authority and directions of the Board of Ordnance, which also supplied them with bedding and the necessary utensils; and any extra articles that were requisite were furnished by the secretary at war. In 1792 orders were issued by the ministry for building cavalry barracks with the utmost dispatch, and the deputy-adjutant-general was directed to superintend the building and fitting them up. In January 1793 the same officer was appointed superintendent-general of barracks; and on the first of May the king's warrant was issued for their regulation. Greater powers were given to the superintendent-general in the year 1794; but as these seemed to interfere with the duties and powers of the Board of Ordnance, a new warrant was issued in the year 1795, defining and limiting the respective duties and powers of the Board of Ordnance, and the superintendent-general, or barrack-master-general, as he was now called. In the year 1796 the barrack-office establishment consisted of a barrack-master-general, with two clerks; a deputy-barrack-master-general; an assistant-barrack-master-general, with three clerks; an accountant, with five clerks; an assistant-barrack-master-general for the general inspection of barracks, and six other assistant-barrack-masters-general for the particular inspection of barracks in different districts; five clerks for general business; one assistant-barrack-master-general for the building branch; one checking clerk, and seven other clerks; two architects and surveyors; one assistant-barrack-master-general in North Britain, with two assistants and clerks; one treasurer; and three other assistant-barrack-masters-general for general duties, and visiting barracks. The salaries and extra pay of these officers amounted in 1796 to L.9524. 17s. 2d. The establishment was afterwards considerably increased, in proportion as the number of barracks throughout the kingdom increased, and by the creation of some new officers, among whom was a law clerk.

During the year 1800 the Commissioners of Military Inquiry began their duties; and their first reports were on the subject of the barrack establishment. In the arrangement of this establishment, and the mode in which its duties were performed, the commissioners pointed out many things that were highly objectionable; and concluded their reports by recommending that the offices of barrack-master-general and deputy-barrack-master-general should be totally abolished, and that the superintendence of the barrack establishment should be vested in commissioners. This suggestion, and some others relative to the mode of transacting the business of the department, and preventing useless and extravagant expenditure, were followed, and the barrack establishment was placed under the direction of four commissioners, one of whom was generally a military man.

But as it frequently happened that barracks required to be built on an emergency, when there was no time to summon a jury to value the land before the commencement of the building, and as most persons were averse to have barracks near their dwelling-houses, or even on their property, government was consequently obliged, in all such cases, to pay an extravagant price for the land which was needed for their erection. In order to remedy this evil, therefore, it was provided by the act usually called the defence act, 43 Geo. III. cap. 55, that justices of the peace might *de plano* put any general officer into the pos-

session of such ground as he might deem fit for the erection of barracks, provided the immediate necessity for such ground was certified by the lord lieutenant or two deputy-lieutenants of the county; the value of the ground so appropriated to be afterwards fixed by a jury in the ordinary way.

Barracks throughout the country are more immediately under the management and care of the resident barrack-masters, especially since the reduction of the barrack-office establishment, and the further reduction of the assistant-barrack-masters-general attached to districts.

The barrack districts in Great Britain are as follow:—
1. the northern, containing Northumberland, Cumberland, Westmoreland, and Durham; 2. York, containing Yorkshire; 3. the eastern, containing Norfolk, Suffolk, Cambridge, Huntingdonshire, and all Essex, except Tilbury-fort; 4. the southern, containing Kent, Tilbury-fort, and Sussex; 5. the south-western, containing Hampshire and Dorsetshire; 6. Isle of Wight; 7. the western, containing Devonshire, Cornwall, and Somerset; 8. Severn, containing Gloucestershire, Herefordshire, Monmouthshire, and South Wales; 9. the north-western, containing Cheshire, Shropshire, Lancashire, North Wales, and the Isle of Man; 10. London; 11. the home, containing Middlesex, Surrey, Hertfordshire, and part of Kent; 12. the north-inland, containing Derbyshire, Nottinghamshire, Staffordshire, Warwickshire, Leicestershire, and Rutlandshire; 13. the south-inland, containing Bedfordshire, Northamptonshire, Oxfordshire, and Buckinghamshire; 14. Jersey, Guernsey, and Alderney.

The Scottish districts are, 1. the northern, containing Caithness, Sutherland, Ross-shire, Inverness-shire, Nairnshire, Morayshire, and Banffshire; 2. the western, containing Aberdeenshire, Argyleshire, Ayrshire, Bute, Kincardineshire, Lanarkshire, Renfrewshire, and Wigtonshire; 3. the central, containing Angusshire, Clackmannanshire, Dumbartonshire, Fifeshire, Kinross-shire, Perthshire, and Stirlingshire; and 4. the southern, containing the Lothians, Berwickshire, Peeblesshire, Selkirkshire, Roxburghshire, and Dumfriesshire.

On the 14th of July 1805 there were in Great Britain, the Island of Jersey, &c. 84 established barracks of brick and stone, 12 of wood, 75 temporary barracks, and 41 rented; in all 212. But the number was afterwards considerably increased. The annual rents at this time amounted to L.40,231. The whole of these barracks were calculated to accommodate nearly 100,000 infantry and 15,000 cavalry. In the cavalry barracks, field-officers have two rooms each; captains one; subalterns, staff, and quarter-masters, one; serjeants of each troop of dragoons, and corporals of each troop of horse, one; eight rank and file one among them; and two rooms are allowed for the officers' mess. In infantry barracks, field-officers are allowed two each; captains one; one is allotted to two subalterns; the staff has one; twelve non-commissioned officers and private men one among them; the serjeant-major and quarter-master-serjeant one; and two are allotted for the officers' mess. The barracks are supplied by the barrack-office with beds, bedding, sheets, blankets, towels, house and stable utensils, coals, and candles; beer was formerly supplied, but now an allowance is made instead of it. Forage is supplied by the commissariat.

The expense of erecting barracks must of course greatly depend on the price of materials at the time, and, in some measure, on the part of the kingdom where they are erected. In the year 1805 permanent barracks for a battalion of 800 men, in the south of England, cost L.37,000; and barracks for 1200 infantry and 400 cavalry L.60,000. The following statement exhibits the several particulars

Barracks.

Barra-
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Barrator.

of the total expense incurred by the nation for barracks, and the barrack-office, in Great Britain, between the 25th of December 1792, and the 10th of November 1804:—

Buildings and purchases of land.....	L.3,930,223	5	8
Forage.....	846,246	7	10
Beer.....	643,030	9	6
Coals, candles, furniture, rents, repairs, supplied by barrack-masters, and salaries.....	1,685,487	8	0
Office-establishment.....	256,129	10	4
Fees at war-office.....	80,346	3	6
Insurance.....	1,519	2	2
Additional rents.....	36,860	13	5
Lodging-money to officers.....	139,582	16	0
Engines.....	11,866	0	5
Bedding, furniture, &c. issued by the barrack-office, and in store.....	1,357,215	7	3
Miscellaneous.....	35,498	4	8

L.9,024,005 8 9

During the last war the annual expense of the barrack establishment in Great Britain varied from L.350,000 to L.500,000. But in Ireland, where barracks are more numerous, the expense generally equalled, and often exceeded, that of Great Britain in this particular. Thus, in 1814, the sum required for Great Britain was L.309,826, whilst that necessary for Ireland was L.360,515; and a similar excess appears in the peace estimate for 1816, which was for Great Britain L.173,500, and for Ireland L.213,000. Since this period the annual expense has of course varied, though within limits so narrow that it seems unnecessary to particularize the sums voted for the service of each year. The barrack estimate of 1828 was, for Great Britain and the colonies L.105,963, and for Ireland L.81,705; that of 1829 amounted, for Great Britain and the colonies, to L.117,636, and for Ireland, to L.102,721. The estimate for 1830 embraces the different heads of repairs; barrack-masters' expenditure; allowances to barrack-masters, serjeants, and miscellaneous charges for barrack service; and colonial expenditure: under the first of which the sums voted were, for Great Britain L.67,746, for Ireland L.60,000; under the second, L.54,827; under the third L.11,762; and under the fourth L.56,539: total, L.250,874.

See first, second, third, and fourth *Reports of the Commissioners of Military Inquiry*, 1806; the *Finance Reports* and *Estimates* laid before parliament for the years 1814 and 1816; and the *Army Estimates* for 1828, 1829, and 1830.

BARRAMAHAL, a district in the south of Hindostan, situated between the twelfth and fourteenth degrees of north latitude. This district was annexed by Hyder to the dominions of Mysore; and in 1792 it was ceded to the British government by the treaty of Seringapatam. At the time it was ceded it was in a miserable state; but it soon recovered under the superintendence of a just and moderate government; and in the course of five years its revenues were more than doubled. This district was not subdued by the Mahommedans until about the middle of the eighteenth century; and hence the population consists chiefly of Hindoos, who outnumber the Mahommedans in the proportion of nineteen to one.

BARRATOR, or BARRETOR, in the law of England, a person guilty of barrety. See BARRETRY.

Lambert conceives the word *barretor* to have been formed from the Latin *balatro*, a vile knave; but the proper derivation is from the French *barrateur*, a deceiver; and this agrees with the description of a common barretor given by Lord Coke, namely, that he is a common mover and maintainer of suits in disturbance of the peace,

particularly by taking and detaining the possession of houses and lands or goods by false inventions or pretences. Hence it is said that a common barretor is the most dangerous oppressor in the law, for he oppresses the innocent under colour of law, which was made to protect them from oppression.

BARRATRY. See BARRETRY.

BARRATRY, in a shipmaster, consists in defrauding the owners. If goods delivered on ship-board are embezzled, all the mariners are bound, by the maritime law, to contribute to the satisfaction of the party that has lost his goods; and the cause is to be tried in the admiralty. In a case where a ship had been insured against the barratry of the master, and the jury found that the ship was lost by the fraud and negligence of the master, the court ruled that the fraud was barratry, though not named in the covenant, but that negligence did not amount to that offence.

BARRAUX, a fortress of Dauphiné, belonging to France, now in the department of Isère. It stands in the valley of Grésivaudan, and was built by a duke of Savoy in 1597. It is seated on the river Isère, in long. 5. 10. E. and. lat. 45. 0. N.

BARRAY, one of the Hebrides, about eight miles in length, of unequal breadth, and of an irregular figure. It produces oats, barley, and potatoes; and it contains about 20,000 superficial acres of wood. The fishery is prosecuted here with great activity, and about 30,000 ling and cod are annually caught and exported. A kind of shark is also taken, from which the fishermen obtain oil for sale or consumption. The rearing of cattle and the burning of kelp afford the chief employment to the inhabitants, who are mostly Roman Catholics. The population amounts to 1969.

BARRE, LOUIS FRANÇOIS JOSEPH DE LA, a French historian and antiquary of some name, was born at Tournay in 1688. Besides various learned papers contributed to the *Memoirs of the Academy of Inscriptions and Belles Letters*, of which he was a member, he published in 1729, *Mémoires pour servir à l'Histoire de France et de Bourgogne*. He also contributed many articles to the edition of Morori's Dictionary, published in 1725, and was concerned in various other works. His death took place, whilst he was preparing a Dictionary of Greek and Roman Antiquities, in May 1738.

BARREL, in *Commerce*, a round vessel made of wood, in the form of a little tun.

BARREL, formerly, was also a measure of liquids. The English barrel, wine measure, contained the eighth part of a tun, the fourth part of a pipe, and one half of a hogshead, or 31½ gallons; a barrel, beer-measure, contained 36 gallons; and a barrel, ale-measure, 32 gallons.

BARREL also denotes a certain weight of several kinds of merchandise, and differs according to the nature of the commodities. Thus a barrel of Essex butter weighs 106 pounds, and of Suffolk butter 256 pounds; a barrel of herrings ought to contain 32 gallons wine-measure, and about 1000 herrings; a barrel of salmon should contain 42 gallons, and a barrel of eels the same; a barrel of soap should weigh 256 lbs.

BARREL, in *Mechanics*, a term given by watch-makers to the cylinder about which the spring is coiled; and by gunsmiths to the cylindrical tube of a gun, pistol, or blunderbuss, through which the ball is discharged.

BARREL, in *Anatomy*. See ANATOMY.

Thundering BARRELS, in the military art, are filled with bombs, grenades, and other fire-works, to be rolled down a breach.

BARREN ISLAND CAPE, an island in the South Pacific Ocean, lying in Bass's Straits, between Great Island

Barratry
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Barren
Island
Cape.

Barren
Island
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Barrington.

on the north and Clarke's Island on the south. It is about twenty miles in length by ten in breadth, and chiefly covered with low vegetation. Long. 148. 10. E. Lat. 40. 23. S.

BARREN ISLAND, an island in the Bay of Bengal, about eighteen miles in circumference. It contains a volcano 1800 feet above the level of the sea, which is sometimes in a state of activity, and discharges immense columns of smoke and showers of red-hot stones. It is 45 miles east of the Lower Andaman Island. Long. 64. 10. E. Lat. 12. 15. N.

BARRETRY, in the *Law of England*, is the offence of frequently exciting and stirring up suits and quarrels between his majesty's subjects, either at law or otherwise. The punishment for this offence in a common person is by fine and imprisonment; but if the offender, as is frequently the case, belongs to the profession of the law, a barretor who is thus able as well as willing to occasion mischief ought for that reason to be disabled from practising for the future. And hence it is enacted by statute 12 Geo. I. c. 29, that if any one who has been convicted of forgery, perjury, subornation of perjury, or common barretry, shall practise as an attorney, solicitor, or agent, in any suit, the court, upon complaint, shall examine it in a summary way, and, if proved, shall direct the offender to be transported for seven years. To this head may also be referred another offence of equal malignity and audacity, that of suing a person in the name of a fictitious plaintiff; in other words, in the name of one who is either not in being at all, or is ignorant of the suit carried on in his name. This offence, if committed in any of the king's superior courts, is left, as a high contempt, to be punished at their discretion; but in courts of a lower degree, where the crime is equally pernicious, although the authority of the judges is not equally extensive, it is directed by statute 8 Elizabeth, c. 2, to be punished by six months' imprisonment, and treble damages to the party injured.

BARRICADE, or **BARRICADO**, a military term for a fence formed in haste with vessels, baskets of earth, trees, palisades, or the like, to serve as a defence against the shot or assault of the enemy. The most usual materials for barricades consist of pales or stakes, crossed with batons, shod with iron at the feet, and usually set up in passages or breaches.

BARRICADE, in *Naval Architecture*, a strong wooden rail, supported by stanchions, extending across the foremost part of the quarter-deck. In a ship-of-war the vacant spaces between the stanchions are commonly filled with rope-mats, cork, or pieces of old cable; and the upper part, which contains a double rope-netting above the rail, is stuffed with hammocks to intercept the flight, and to prevent the execution, of small-shot in time of action.

BARRIER, in *Fortification*, a kind of fence erected at a passage, retrenchment, or breach, to stop up the entry there. It is composed of great stakes, about four or five feet in height, placed at the distance of eight or ten feet apart, with transoms or overthwart rafters to stop either horse or foot that would enter or rush in with violence, while in the middle there is a movable bar of wood that opens or shuts at pleasure.

BARRINGTON, **JOHN SHUTE**, Lord Viscount Barrington, a nobleman distinguished for theological learning, was the youngest son of Benjamin Shute, merchant, and was born in 1678. He received part of his education at the university of Utrecht; and, after returning to England, studied law in the Inner Temple. In 1701 he commenced author by writing in favour of the civil rights of Protestant dissenters, to which body he belonged. On the recommendation of Lord Somers, he was employed to

engage the Presbyterians in Scotland to favour the union of the two kingdoms; and, in 1708, he was rewarded for this service, by being appointed to the office of commissioner of the customs. From this, however, he was removed by the Tory ministry of Queen Anne; but his fortune had, in the meantime, been improved by the bequest of two considerable estates, one of them left him by Francis Barrington of Tofts, Esq. whose name he assumed by act of parliament. Mr Barrington now stood at the head of the dissenters. On the accession of George I. he was returned member of parliament for Berwick-upon-Tweed; and in 1720 the king raised him to the Irish peerage, by the style and title of Viscount Barrington of Ardglass. But having unfortunately engaged in one of the bubbles of the time, the Harburg lottery, he incurred the disgrace of expulsion from the House of Commons in 1723; a punishment which was thought greatly too severe, indeed altogether unmerited on his part. In 1725 he published his principal work, entitled *Miscellanea Sacra, or a New Method of considering so much of the History of the Apostles as is contained in Scripture, in an Abstract of their History, an Abstract of that Abstract, and four Critical Essays*, 2 vols. 8vo. This work, which traces the methods employed by the first preachers of the gospel in propagating Christianity, and explains the several gifts of the Spirit by which they were enabled to discharge their office, has always been reckoned a valuable and judicious defence of the Christian cause; and it was reprinted with additions and corrections, in 3 vols. 8vo, 1770, by his son, afterwards bishop of Durham. In the same year (1725) he published *An Essay on the several Dispensations of God to Mankind*, in the order in which these are unfolded in the Scriptures; and he was the author of various other tracts, chiefly on subjects relating to toleration in matters of religion. He died in 1734, in the 56th year of his age, leaving a number of children, of whom five sons had the singular good fortune to rise to high stations in the church, the law, the army, and the navy. Lord Barrington was a friend and disciple of Locke, whose sentiments he adopted as to the right and advantage of free inquiry, and the value of civil and religious liberty; and he contributed greatly to the rising spirit of liberal scriptural criticism amongst those who wished to render religion a subject of rational belief. He was a man of great moderation, and, though chiefly connected with the dissenters, he occasionally frequented and communicated with the established church.

BARRINGTON, **Daines**, fourth son of Lord Viscount Barrington, distinguished as an antiquary and naturalist, was educated for the profession of the law, and, after filling various posts, was appointed a Welsh judge in 1757, and afterwards second justice of Chester. He never rose to much eminence at the bar, but he showed his knowledge of the law as a subject of liberal study, by a valuable publication entitled *Observations on the Statutes, chiefly the more ancient, from Magna Charta to 21 James I. c. 27, with an Appendix, being a proposal for new-modelling the Statutes*, 1766, 4to; a work which has been quoted with merited commendation by many of our historians and constitutional antiquaries. In 1773 he published an edition of Orosius, with Alfred's Saxon version, and an English translation with notes of his own, which was severely animadverted on by the critics. His *Tracts on the Probability of reaching the North Pole*, 1775, 4to, were written in consequence of the northern voyage of discovery undertaken by Captain Phipps, afterwards Lord Mulgrave. In these he has accumulated a variety of evidence favourable to his own opinion of the practicability of attaining the object in which that voyage had failed; and it is not improbable that his views and arguments had some effect in

Barrington.

Barrister. determining the government of our time to renew the attempt, though with no better success. Mr Barrington's other writings are chiefly to be found in the publications of the Royal and Antiquarian Societies, of both of which he was long an assiduous member, and of the latter vice-president. These relate to a variety of topics in natural history and antiquities, and show great industry and research, though with an occasional leaning to singularity and paradox. Many of his tracts were collected by him in a quarto volume entitled *Miscellanies on various Subjects*, 1781. His *Experiments and Observations on the Singing of Birds*, and his *Essay on the Language of Birds*, are among the most curious and ingenious of his papers, and, with other productions of his pen, prove that he was not only deeply conversant with books, but an attentive and sagacious observer of nature. In private life he was a man of worth and integrity, unambitious, and devoted to study and literary conversation. He resigned his office of justice of Chester in 1785, and afterwards lived in retirement in his chambers in King's-Bench Walks, Inner Temple; associating chiefly with his brother benchers, and amusing himself with superintending the improvements of the gardens. He died on the 14th March 1800, and was buried in the Temple church.

BARRISTER, is a counsellor learned in the law, admitted to plead at the bar, and there to take upon him the protection and defence of clients. Barristers at law are now termed *jurisconsulti*; in other countries they are called *licentiati in jure*; but anciently they were styled apprentices of the law, in Latin *apprenticii juris nobiliores*. In former times eight years elapsed before they could be called to the bar; but the term was latterly reduced to five. The exercises required of them, if not *ex gratia*, were twelve grand moots performed in the inns of Chancery in the times of the grand readings, and twenty-four petty moots in the term times, before the readers of the respective inns; and a barrister newly called is required to attend the six (or four) next long vacations, the exercise of the house, in Lent and summer, and is thereupon for those three (or two) years styled a *vacation barrister*. Persons thus serving their noviciate are also called *utter barristers*, or pleaders *ouster* the bar, to distinguish them from benchers, or those that have been readers, who are sometimes admitted to plead within the bar, in the same manner as the king's, queen's, or prince's counsel are.

No particular course of professional training is prescribed to candidates for admission as advocates to the Scotch bar. It is now understood, however, if not required, that, besides passing through the ordinary course of academical education, they shall have attended the classes of Scotch Law in the university of Edinburgh; and, in point of fact, such attendance is almost indispensably necessary to enable them to undergo the preliminary examinations. These are two; one, on the civil or Roman law, when the candidate is examined either on Heineccius *ad Pandectas* or on the *Institutions* of Justinian; the other, on the Scotch law, the text book for which is Erskine's *Principles of the Law of Scotland*; and a year must intervene between them. The writing and impugnation of a Latin thesis on a title of the Digest follow the examination on Scotch law; but this has come to be so much a matter of mere form, not to say mockery, and in point of fact so few of the candidates write their own theses (which, indeed, are for the most part very insignificant productions) that it has been proposed to abolish it altogether, and to appropriate the sum usually disbursed on account of this superannuated ceremony to the use of the Advocates' Library. The fees paid on admission are considerable, amounting, in consequence of a recent regulation, to nearly L.400.

BARRITUS, a word of German origin, adopted by the Romans to signify the general shout usually raised by the soldiers of their armies on their first encounter, after the *classicum* or alarm.

BARROS, JOHN DE, a celebrated Portuguese historian, born about 1496. He was educated at the court of King Emanuel, among the princes of the blood, and made great progress in Latin and Greek. The Infant John, to whom he attached himself and became preceptor, having succeeded the king his father in 1521, De Barros obtained a place in this prince's household; and, in 1522, he was made governor of St George del Mina, on the coast of Guinea. Three years after, the king having recalled him to court, made him treasurer of the Indies; and this post inspired him with the thought of writing the well-known and valuable history entitled *Azia Portuguesa*, for which purpose he retired to Pompas, where he died in 1571. His work is divided into decades, the first of which he published in 1552, the second in 1553, and the third in 1563; but the fourth decade was not published till the year 1615, when it appeared by order of King Philip III., who caused the manuscript to be purchased from the heirs of De Barros. Several authors have continued the work, so that it extends to twelve decades. A handsome edition of the original work, and its continuations, was published at Lisbon in 1774, in 11 vols. 8vo.

BARROW, ISAAC, an eminent mathematician and divine, was the son of Mr Thomas Barrow, a linen-draper in London, where he was born in 1630. He was at first placed for two or three years at the Charter-house School. There, however, his conduct gave but little hopes of success in the profession of scholar; for he was extremely fond of fighting, and of promoting pugnacity among his school-fellows. But being removed from this establishment, his disposition took a happier turn; and having soon made considerable progress in learning, he was admitted a pensioner of Peter-house, in Cambridge, where he applied himself with great diligence to the study of literature and science, especially of natural philosophy. He afterwards turned his thoughts to the profession of physic, and made some progress in anatomy, botany, and chemistry; after which he studied chronology, geometry, and astronomy. He then travelled into France and Italy, and in a voyage from Leghorn to Smyrna gave proofs of great personal bravery; for the ship having been attacked by an Algerine pirate, Mr Barrow remained upon deck, and fought with the utmost intrepidity, until the pirate, unprepared for the stout resistance made by the ship, sheered off and left her to pursue her voyage unmolested.

At Smyrna he met with a most kind reception from Mr Bretton, the English consul, upon whose death he afterwards wrote a Latin elegy. From this place he proceeded to Constantinople, where he received similar civilities from Sir Thomas Bendish, the English ambassador, and Sir Jonathan Dawes, with whom he afterwards contracted an intimate friendship. While at Constantinople he read and studied the works of Chrysostom, once bishop of that see, whom he preferred to all the other fathers. He resided in Turkey somewhat more than a year, after which he proceeded to Venice, and thence returned home through Germany and Holland in 1659. Immediately on his return he received episcopal ordination from Bishop Brownrig, and in 1660 he was appointed to the Greek professorship at Cambridge. When he entered upon this office, he intended to have prelected upon the tragedies of Sophocles; but he altered his intention, and made choice of Aristotle's rhetoric. His lectures on this subject, however, having been lent to a friend who never returned them, are irrecoverably lost. In July 1662 he was elected professor of geometry in Gresham College, on the recommendation of

Barritus
||
Barrow.

Fig. 99



Fig. 100
First
Distance of the fourth Satellite from the Earth

EARTH

MOON

Distance of the Moon from the Earth

SATURN
4th Satellite

First

Second

Third

Fourth

Fifth
Satellite from
the Earth



No particular course of professional training is prescribed to candidates for admission as advocates to the Scottish bar. It is now understood, however, it was required that, besides passing through the ordinary course of academic education, they shall have attended the classes of Scotch Law in the university of Edinburgh; and, in point of fact, such attendance is almost indispensably necessary to enable them to undergo the preliminary examinations. These are two; one, on the civil or Roman law, when the candidate is examined either on Heineccius *ad Pandectas* or on the *Institutiones* of Justinian; the other, on the Scotch law, the text book for which is Erskine's *Principles of the Law of Scotland*; and a year must intervene between these. The writing and impagnation of a Latin thesis on a title of the Digest follow the examination on Scotch law; but this has come to be so much a matter of mere form, and so to say mockery, and in point of fact so few of the candidates write their own theses (which, indeed, are for the most part very insignificant productions) that it has been proposed to abolish it altogether, and to appropriate the sum usually disbursed on account of this superannuated ceremony to the use of the Advocates' Library. The fees paid on admission are considerable, amounting, in consequence of a recent regulation, to nearly £400.

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148504. — One of a celebrated Portuguese historian, born about 1490. He was educated at the court of King Manuel, among the princes of the blood, and made great proficiency in Latin and Greek. The Infant John, to whom he was attached, and became preceptor, having succeeded to the throne in 1521, De Barros obtained admission into the king's household; and, in 1522, he was appointed historiographer of St George del Mina, on the coast of Brazil. Three years after, the king having recalled him to Portugal, made him treasurer of the Indies; and this post occupied him with the thought of writing the well-known and valuable history entitled *Azia Portuguesa*, for which he was rewarded by Pompa, where he died in 1571. His work is divided into decades, the first of which he published in 1551, the second in 1553, and the third in 1561. The fourth decade was not published till the year 1613, when it appeared by order of King Philip III., who caused the manuscript to be purchased from the heirs of De Barros. Several authors have continued the work, so that it amounts to twelve decades. A handsome edition of the original work, and its continuations, was published at Lisbon in 1774, in 11 vols. 8vo.

BARROW, Isaac, an eminent mathematician and astronomer, was the son of Mr Thomas Barrow, a linen-draper in London, where he was born in 1680. He was at first placed for some three years at the Charter-house School, Thetford, where, his conduct gave but little hopes of success in the pursuit of science; but he was extremely fond of reading, and of performing experiments among his books. He then being recommended to the Rev. Isaac Newton, D. D. of Cambridge, and a learned man, soon finding some talents for philosophy, and a great proficiency in mathematics, he was removed to a private school at Cambridge, and continued to study under the great Isaac Newton, till the year 1702, when he was appointed lecturer in astronomy, and afterwards in natural philosophy. He afterwards became the assistant to the professor of physic, and made considerable discoveries in anatomy, botany, and chemistry; after which he studied astronomy, geometry, and astronomy. He then travelled into France and Italy, and in a voyage from Leghorn to Sicily gave proofs of great personal bravery; the ship having been attacked by an Algerian pirate. Mr Barrow remained upon deck, and fought with the utmost intrepidity, until the pirate, unprepared for the stout resistance made by the ship, sheered off and left her to pursue her voyage unmolested.

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ASTRONOMY.

PLATE LXXXVIII.

Fig. 97.



Fig. 98.



Fig. 103.

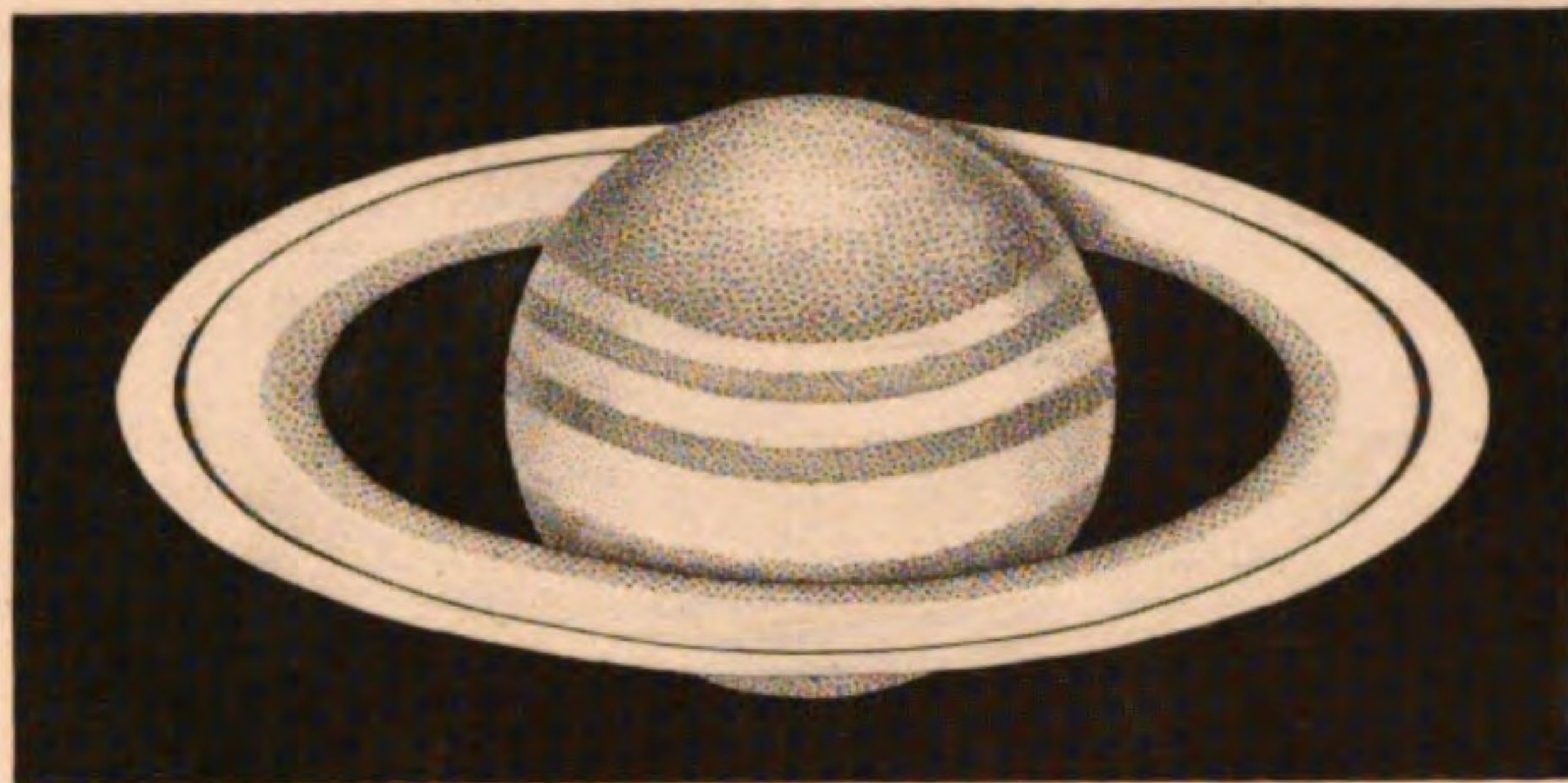


Fig. 99.



Fig. 100.



Fig. 102.

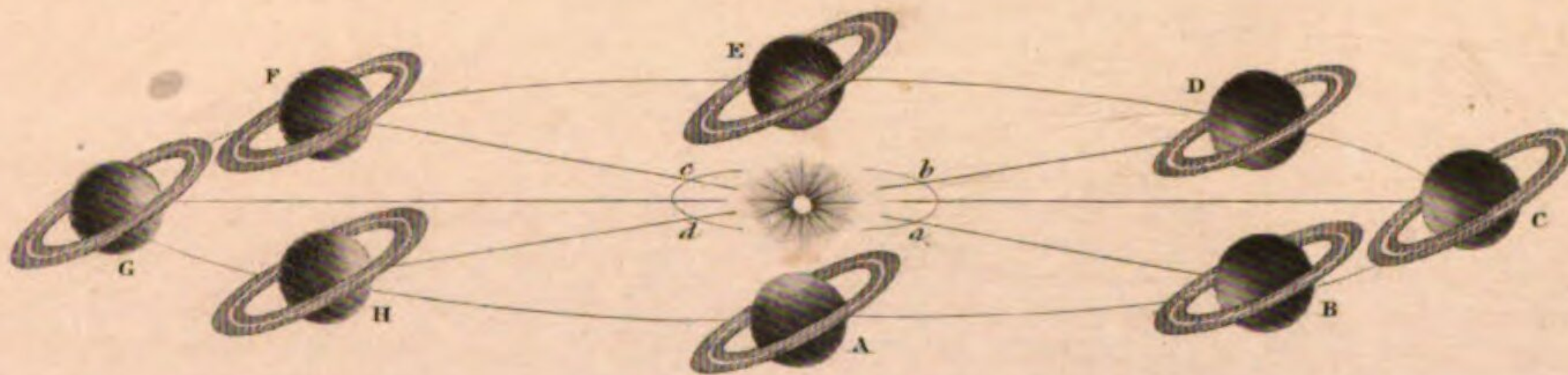
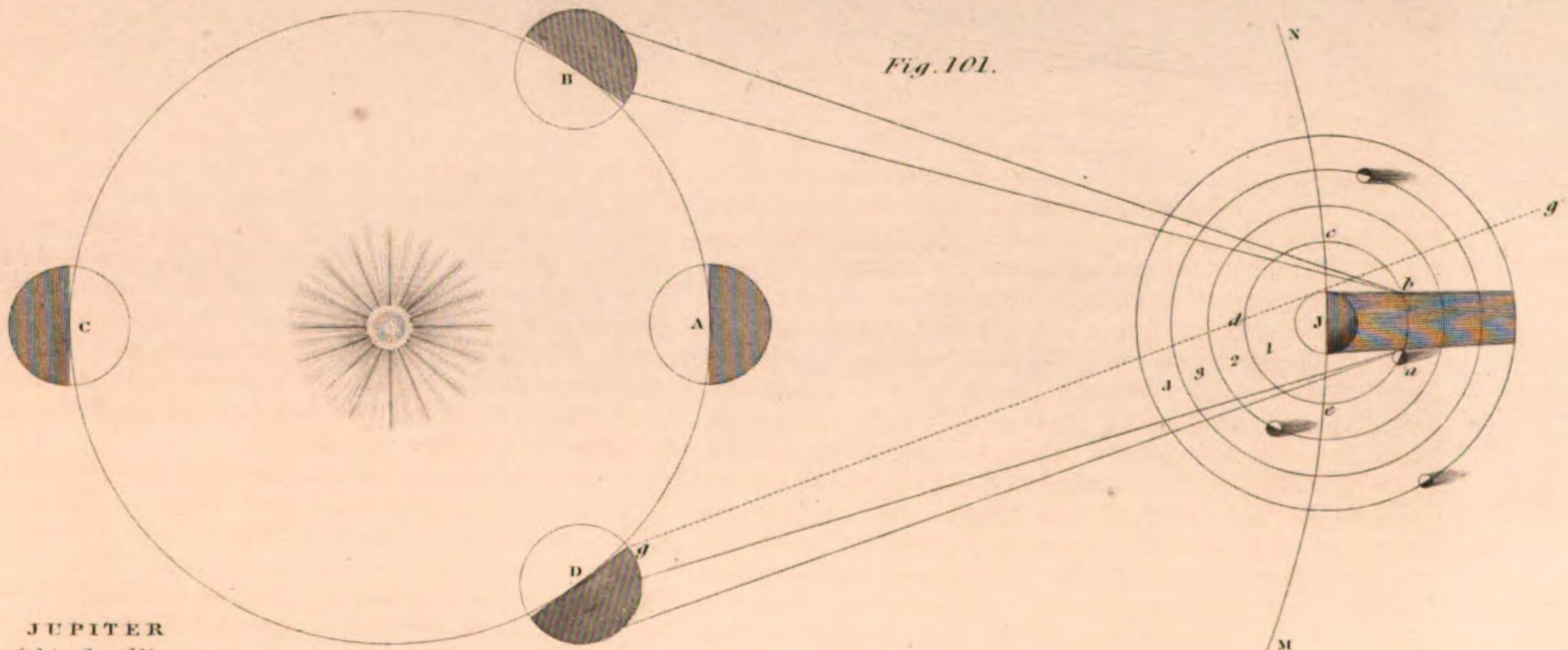


Fig. 101.



JUPITER
& his Satellites.

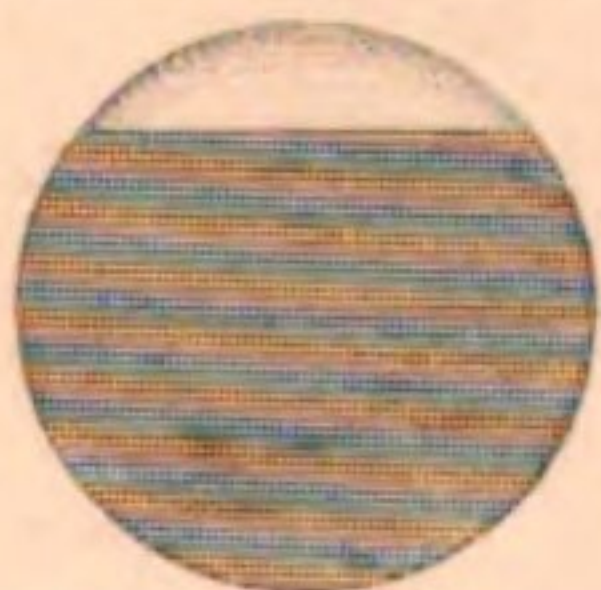


Fig. 105.

First Second Third
Distance of the fourth Satellite from the third.

EARTH MOON
Distance of the Moon from the Earth.

SATURN
& his Satellites.

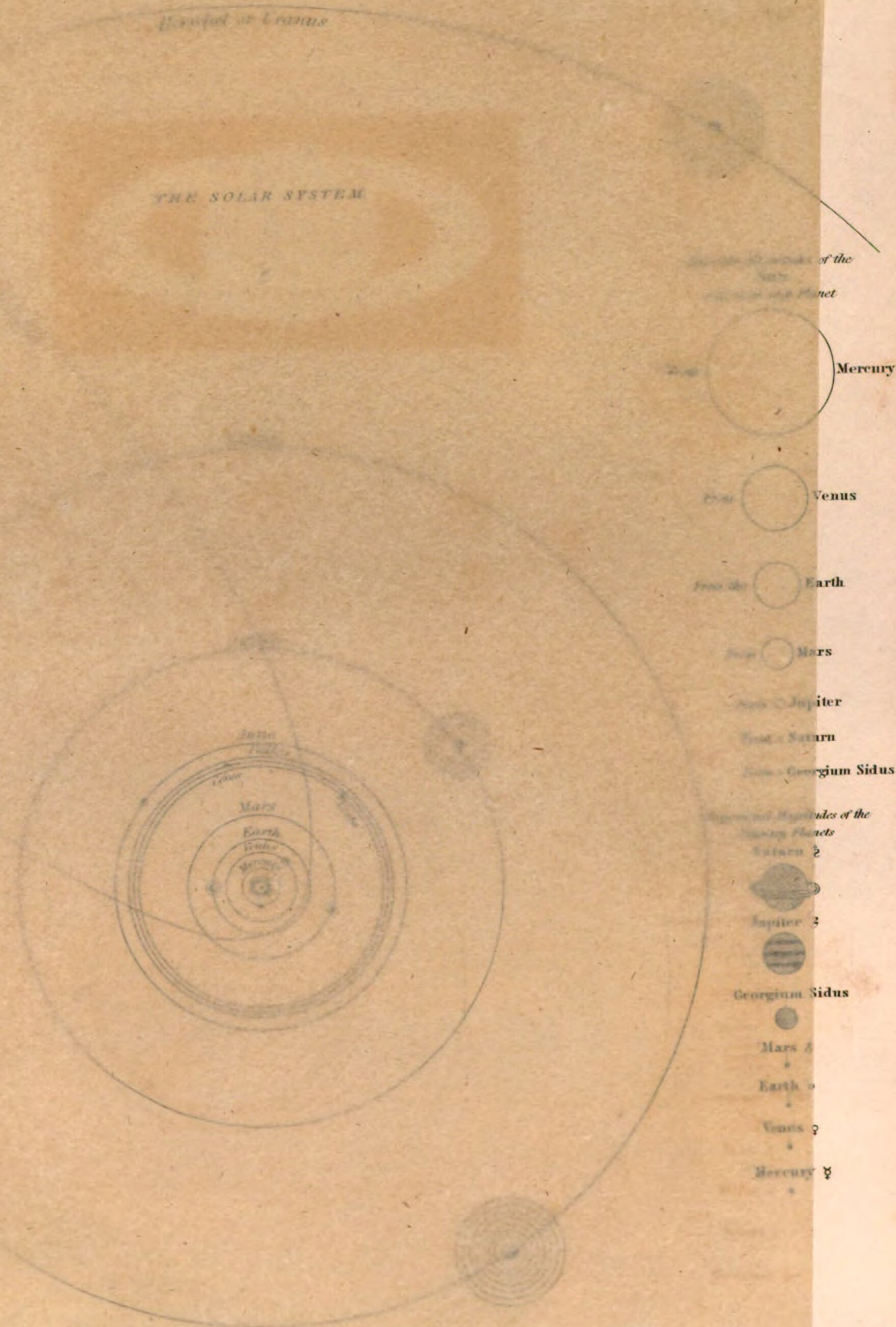


First Second Third Fourth Fifth
Satellite thrice the distance of the Fourth.

Fig. 101.

Harvard at Uranus

THE SOLAR SYSTEM



Distance of the Sun from each Planet

Mercury

Venus

Earth

Mars

Jupiter

Saturn

Georgian Sidus

Magnitudes and Symbols of the Planets

Saturn 2

Jupiter 3

Georgian Sidus

Mars 4

Earth 0

Venus 9

Mercury 8

ASTRONOMY.

PLATE LXXXIX.

Fig. 104.

Herschel or Uranus

THE SOLAR SYSTEM.

Orbit of a Comet

Saturn

Jupiter

Juno

Pallas

Ceres

Mars

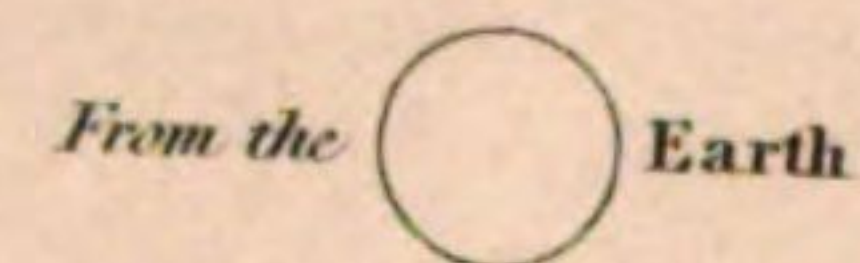
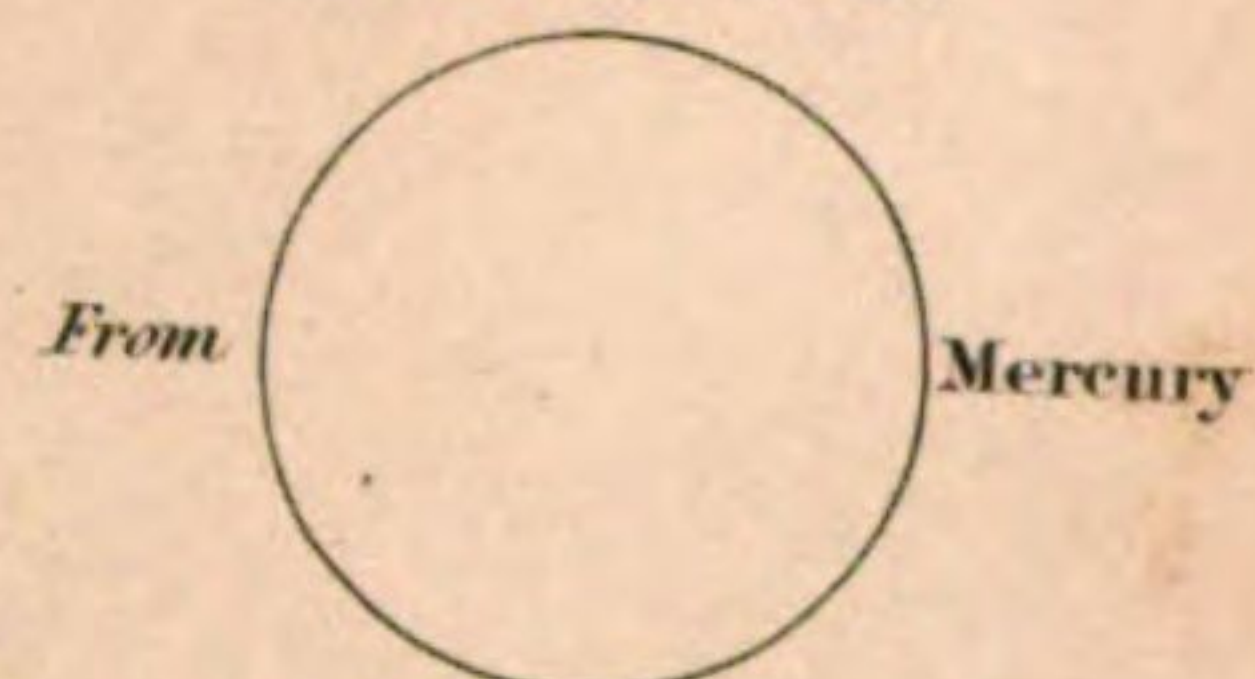
Earth

Venus

Mercury

Vesta

*Apparent Magnitudes of the Sun
seen from each Planet*



From Jupiter

From Saturn

From Georgium Sidus

*Proportional Magnitudes of the
Primary Planets*

Saturn $\frac{1}{2}$



Jupiter $\frac{3}{4}$



Georgium Sidus



Mars $\frac{1}{8}$



Earth $\frac{1}{16}$



Venus $\frac{1}{32}$



Mercury $\frac{1}{64}$



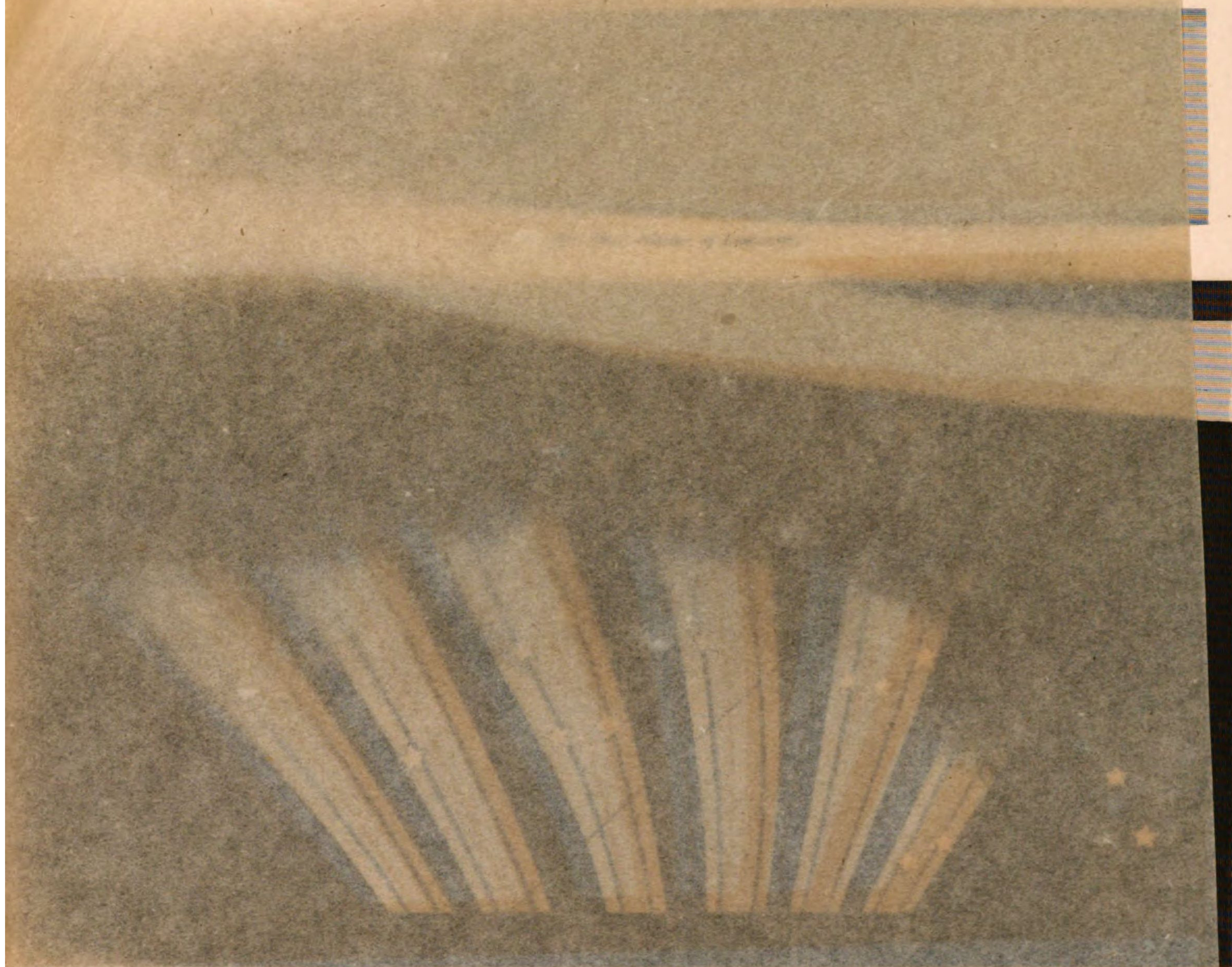


Fig. 107.

Comet of 1743

according to Chéseaux

THE MUSEUM

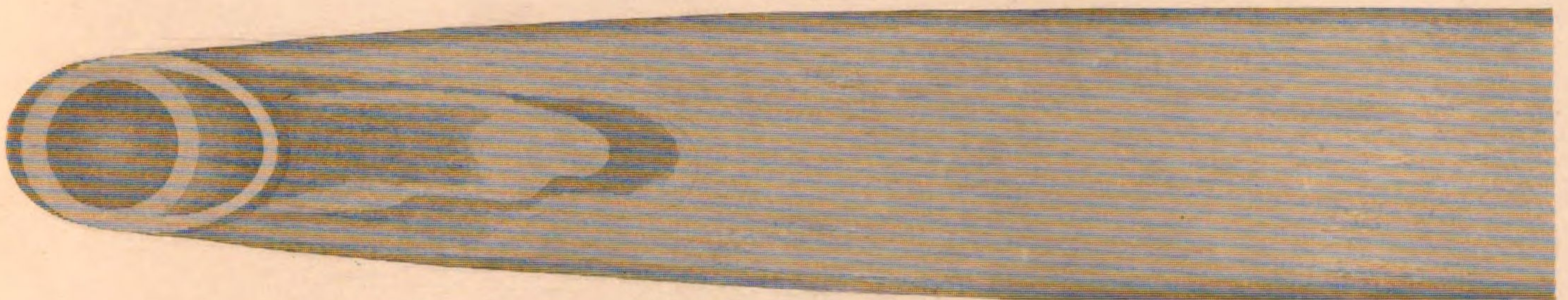
OF THE HISTORY OF THE

AMERICAN PEOPLE

OF THE AMERICAN PEOPLE



Fig. 106.



Comet of 1680. Hist. Celeste. of Lemonnier.

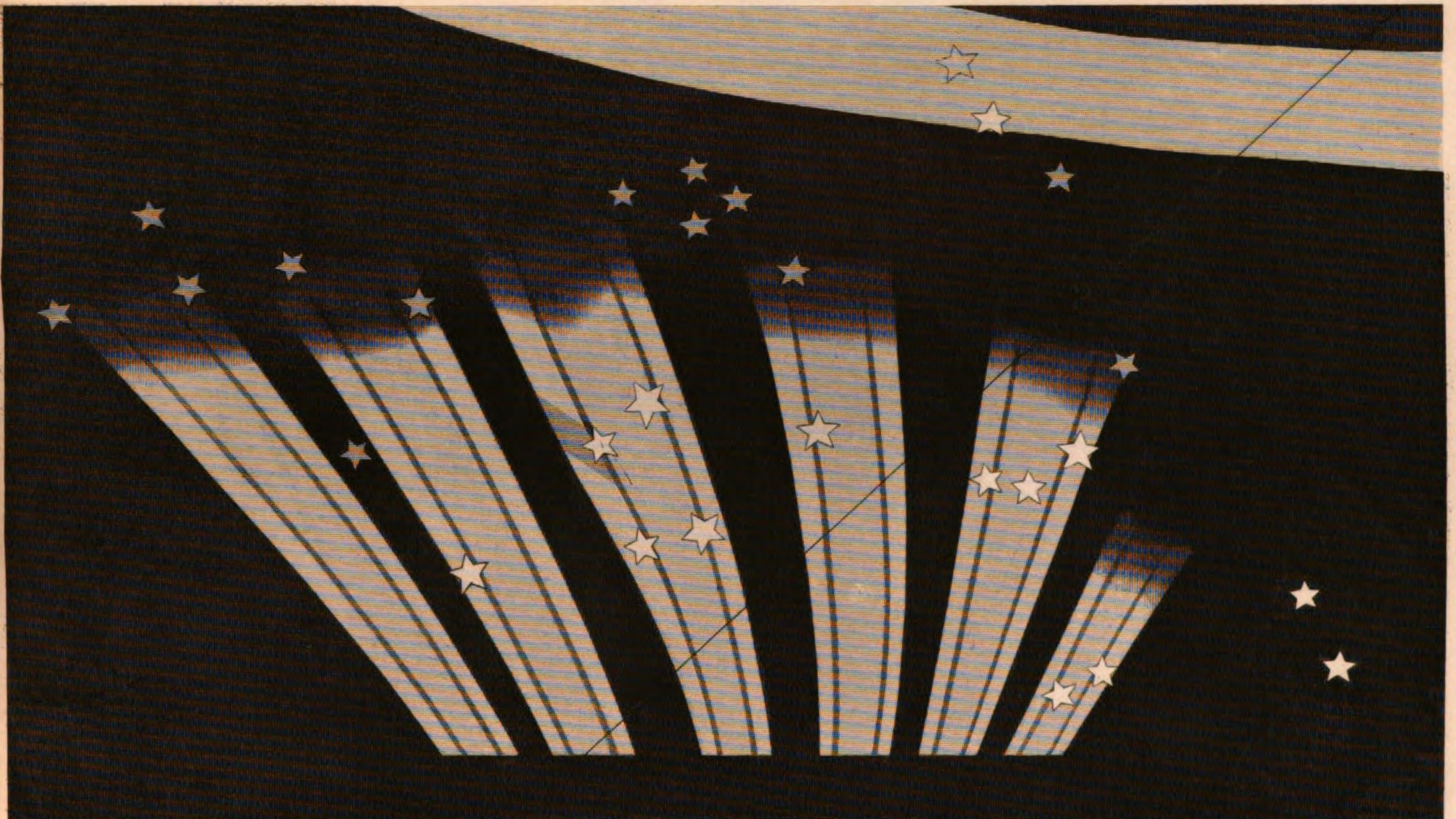
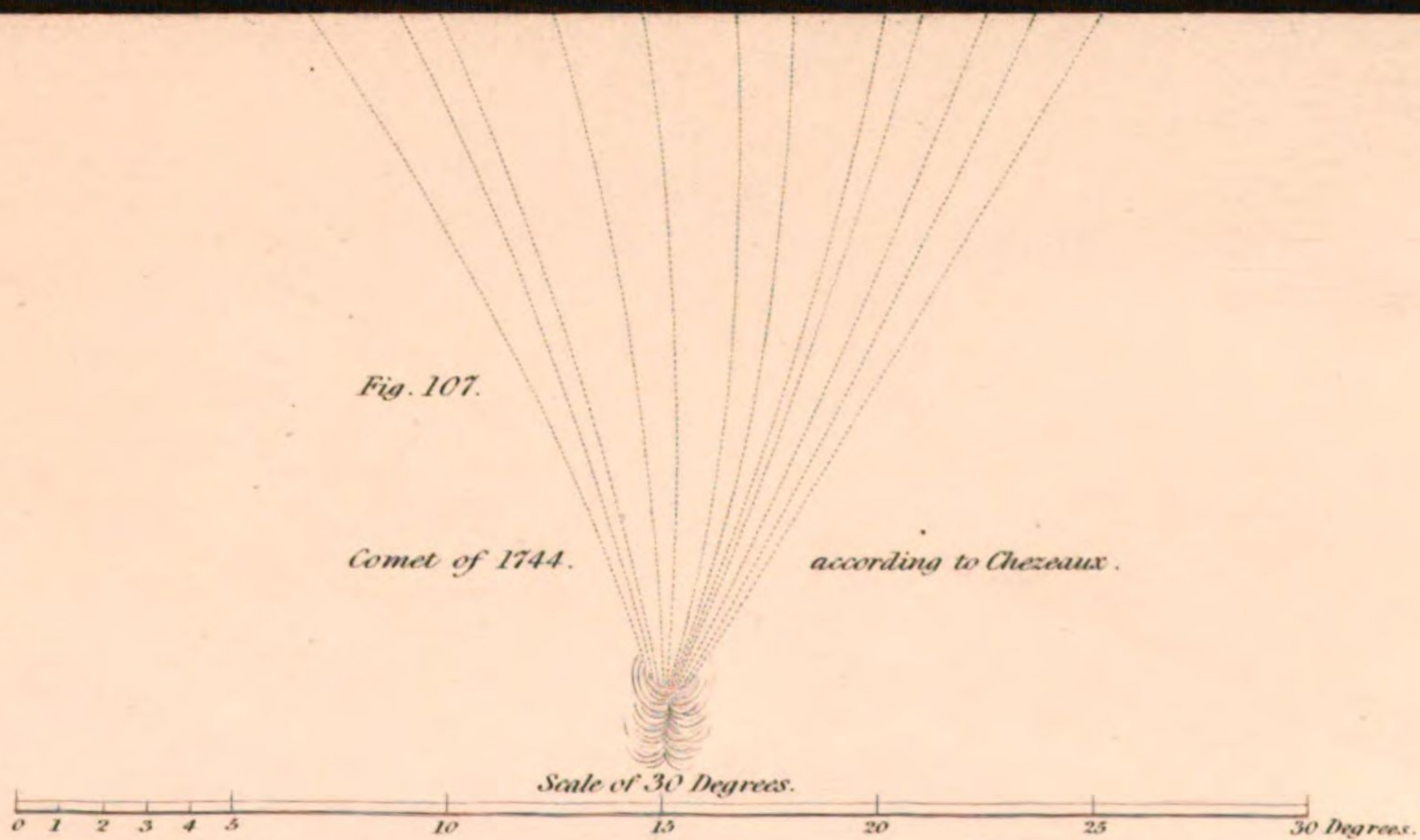


Fig. 107.

Comet of 1744.

according to Chezeaux.



ASTRONOMY.

PLATE XXI.

Fig. 1. The position of the Earth in its orbit on the 1st July 1873.

Fig. 108.

Nebula in the Sword Handle of Orion as seen on the 1st Feb^r 1824.

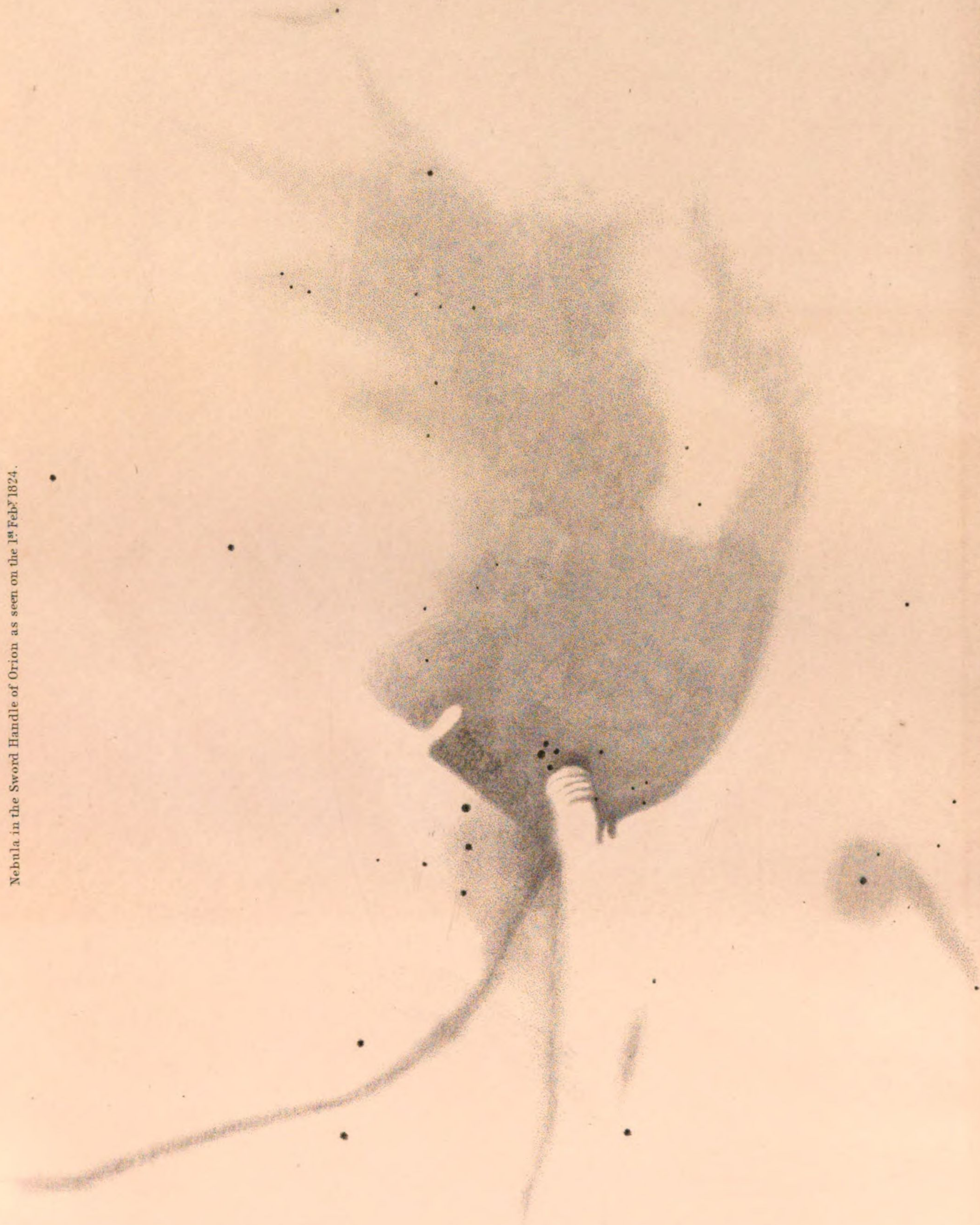


Fig. 109.

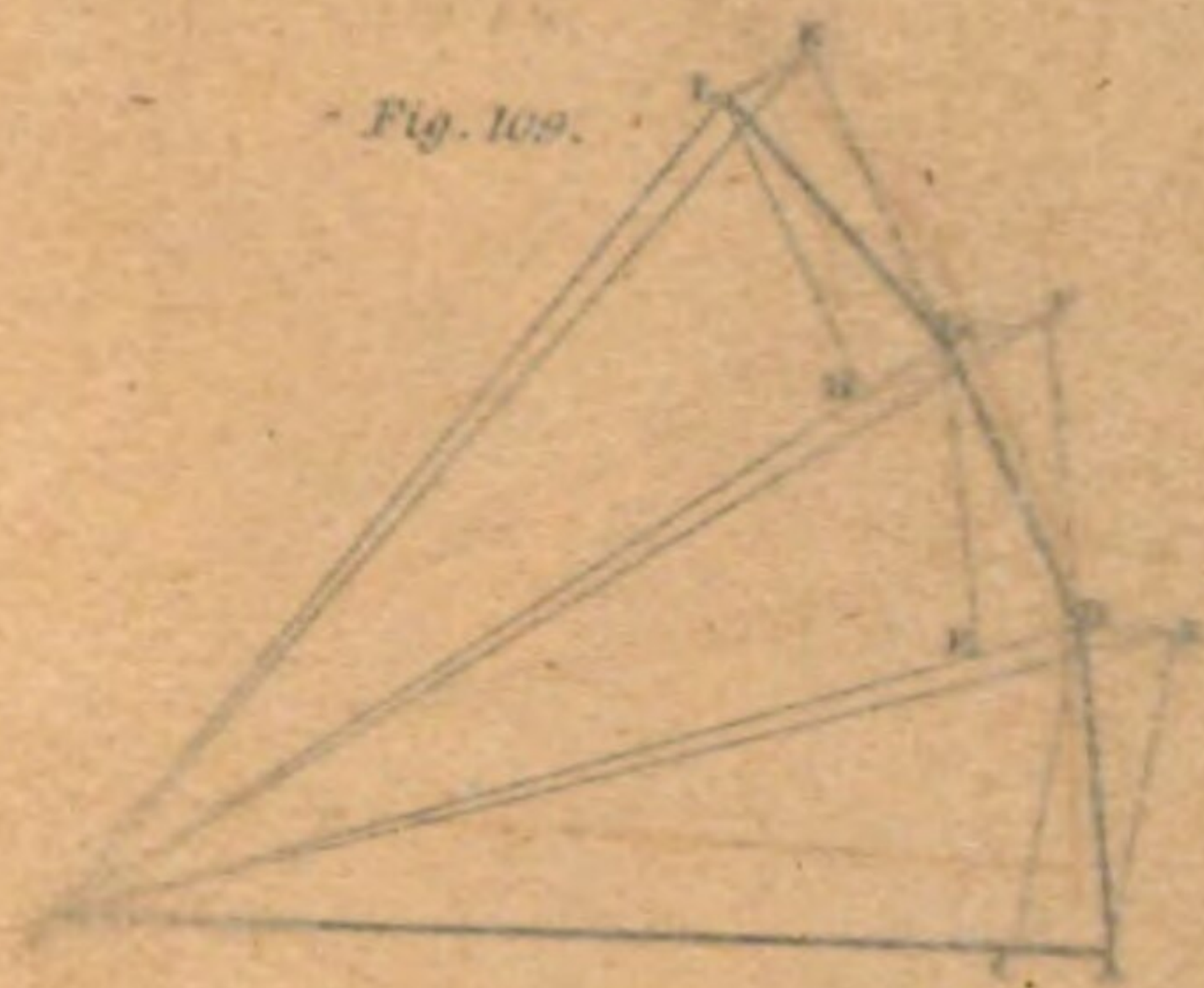


Fig. 110.



Fig. 111.



Fig. 112.



Fig. 113.

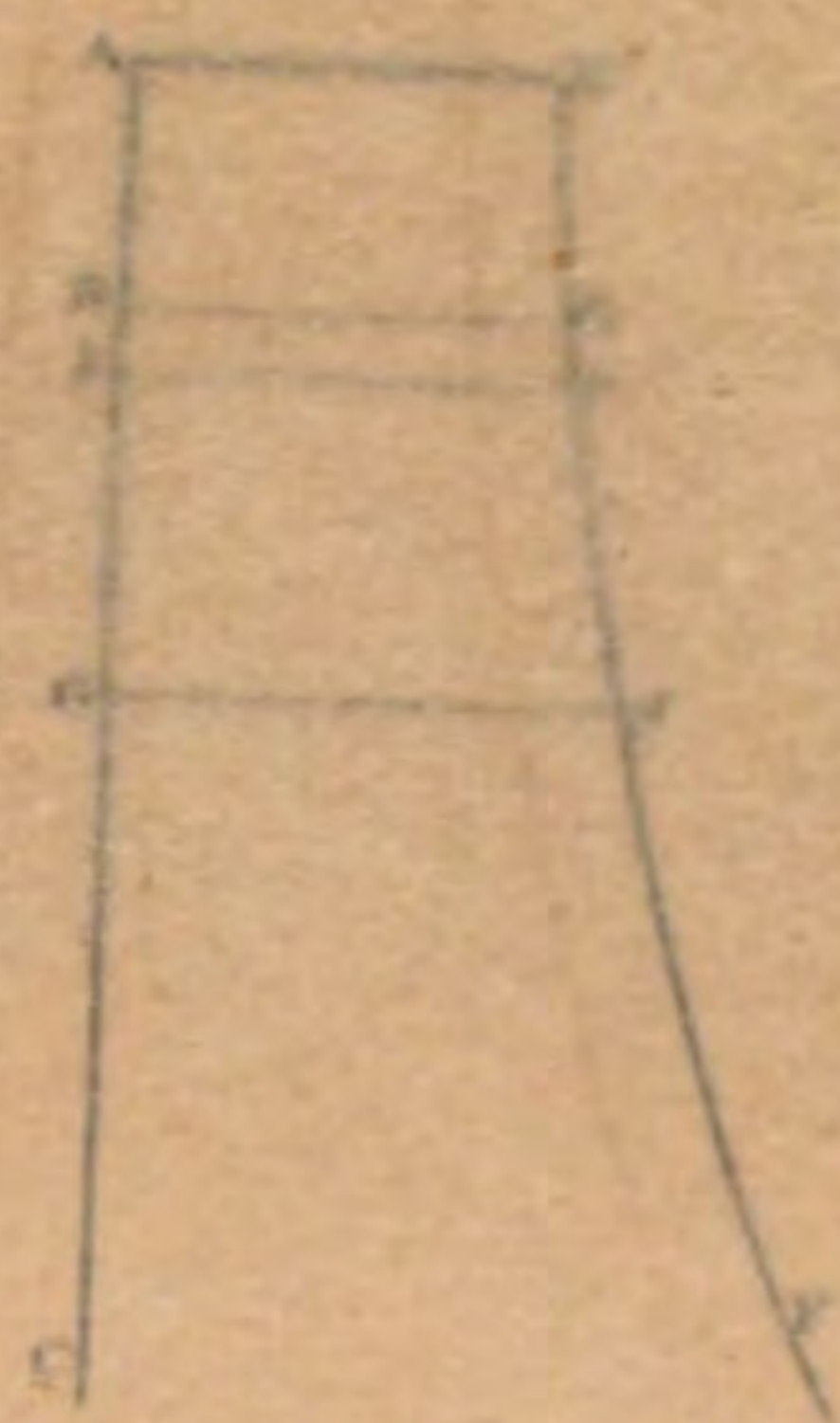


Fig. 114.



Fig. 115.



Fig. 116.

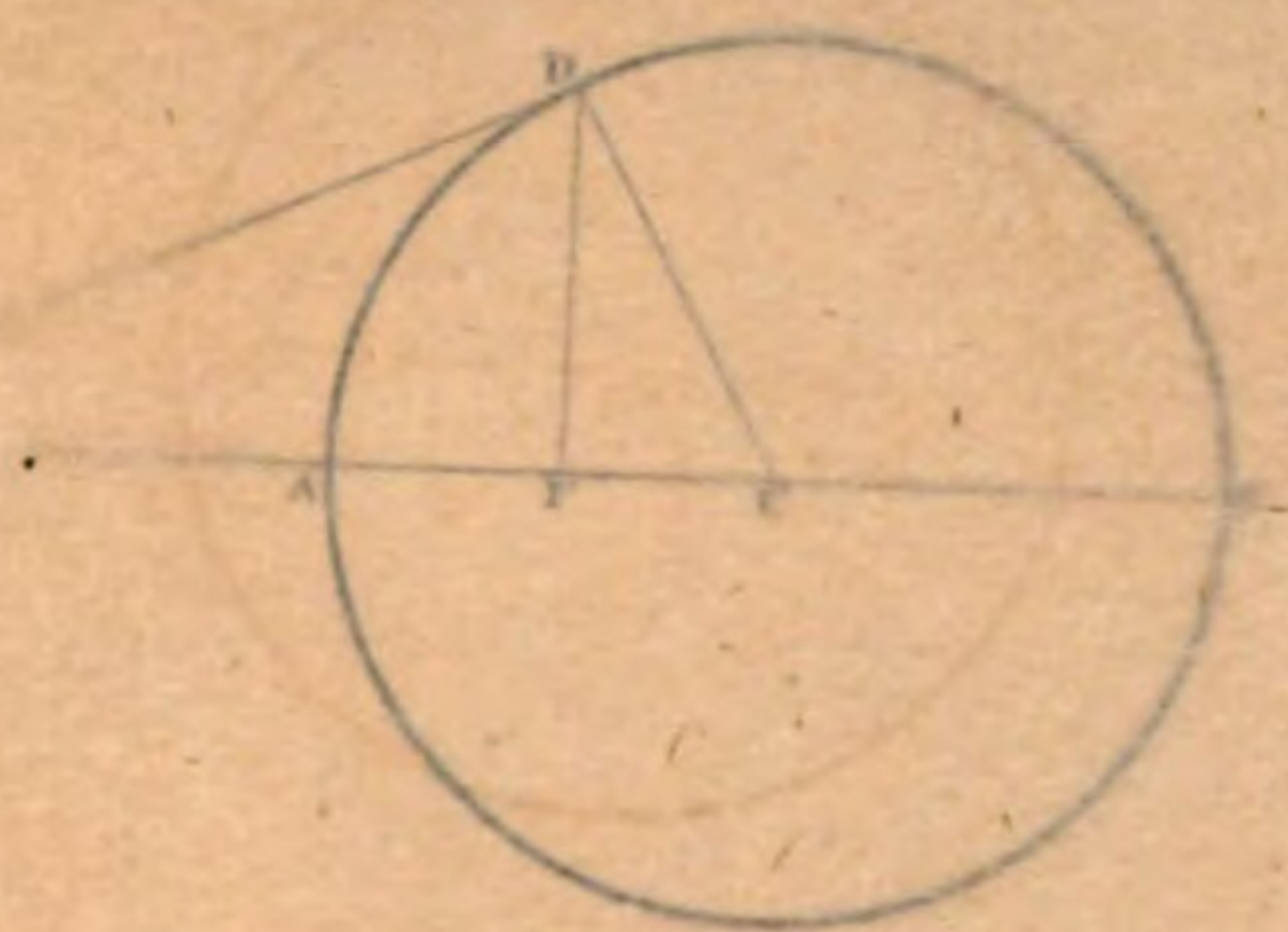


Fig. 117.



Fig. 118.

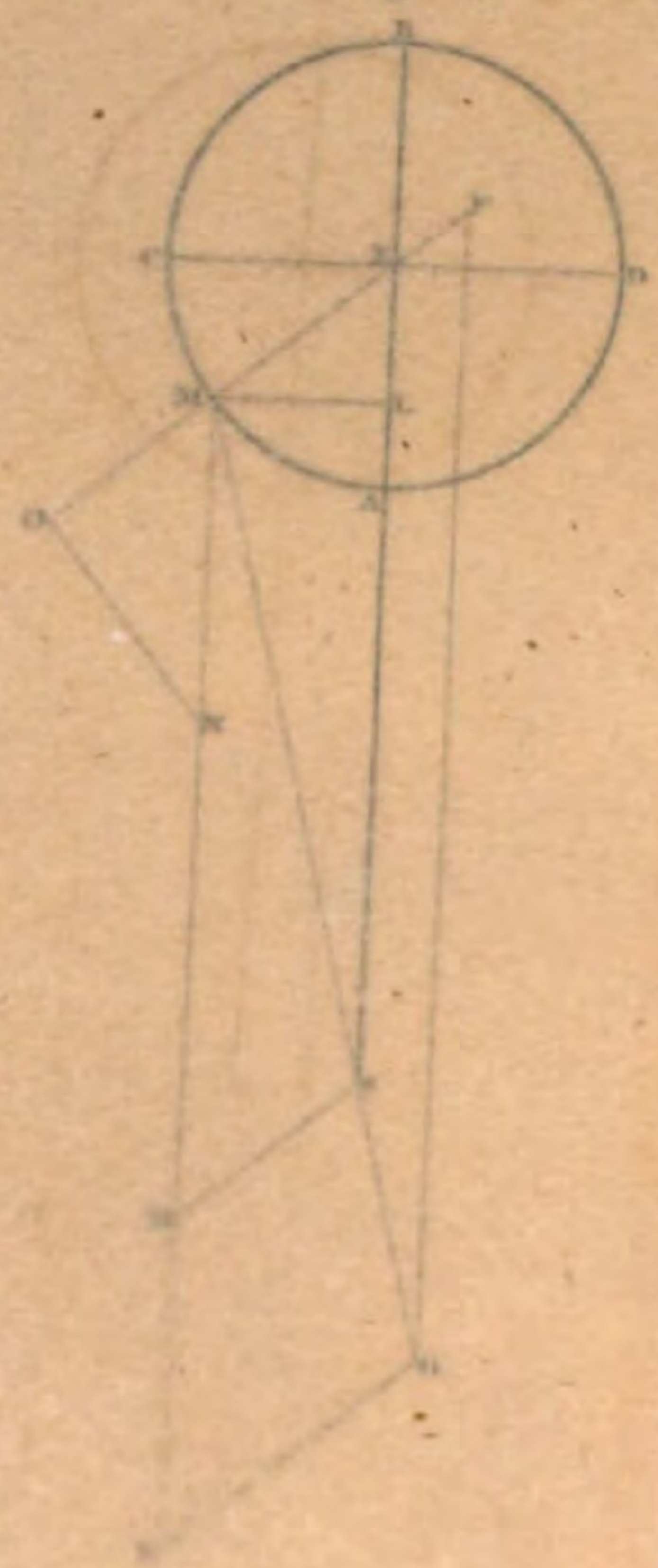
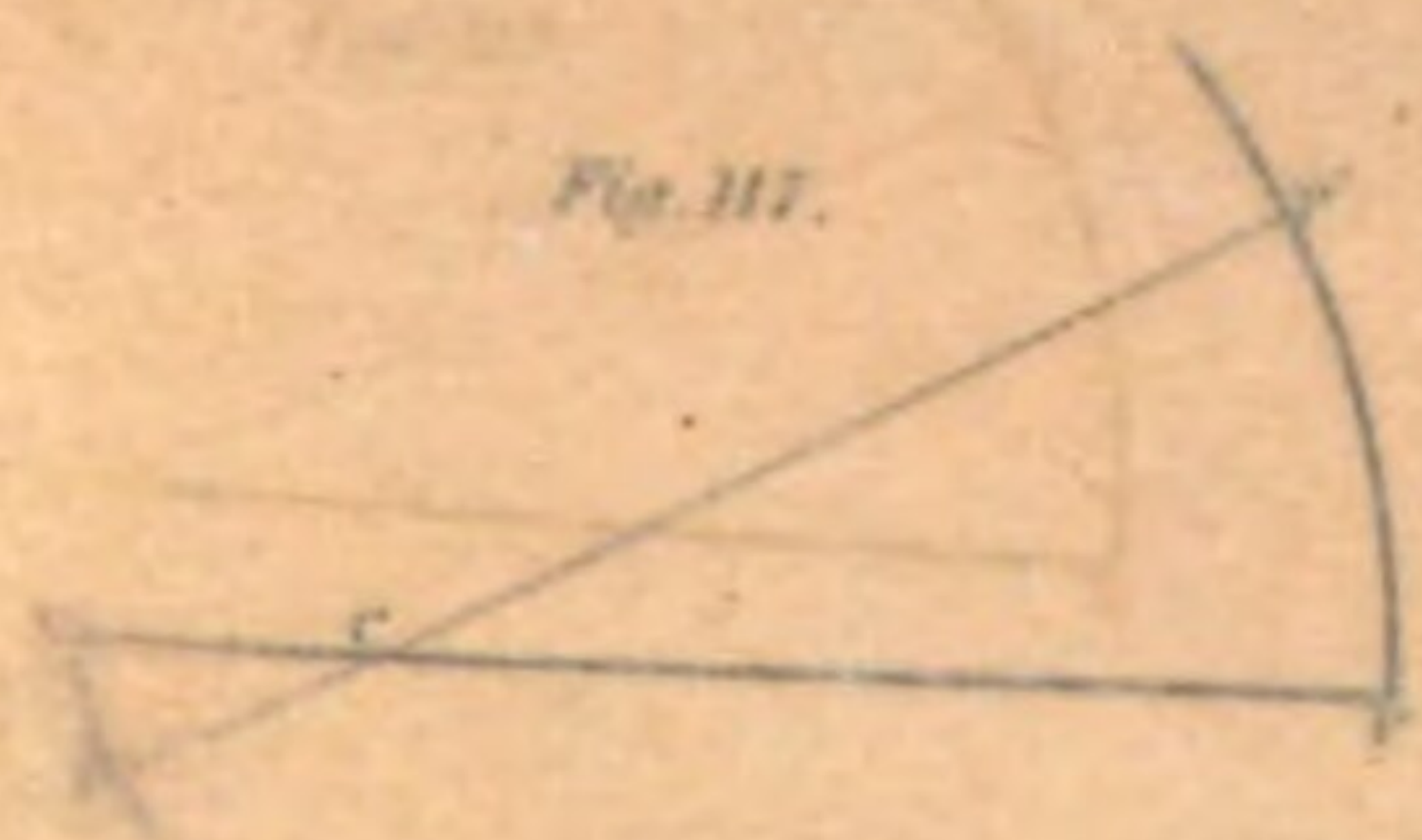
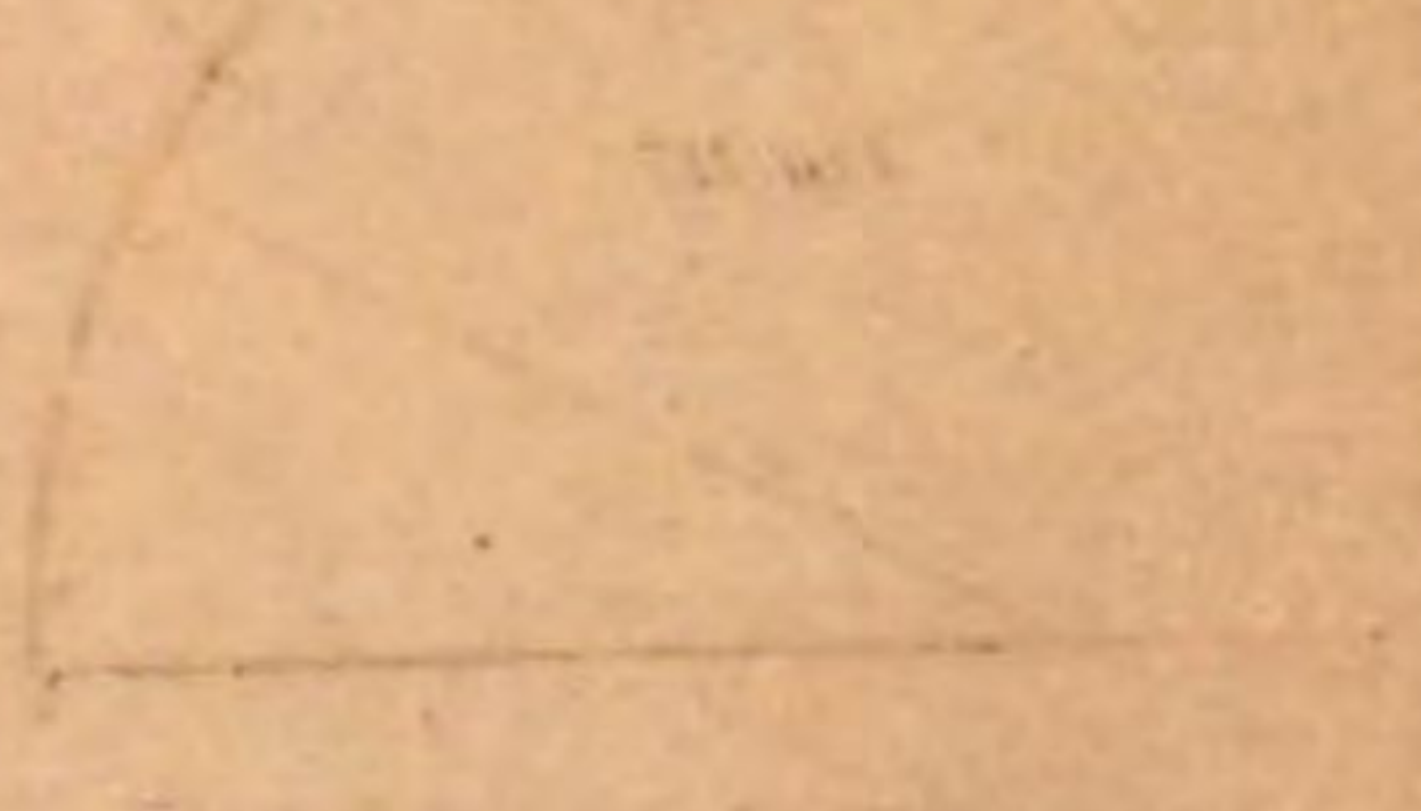
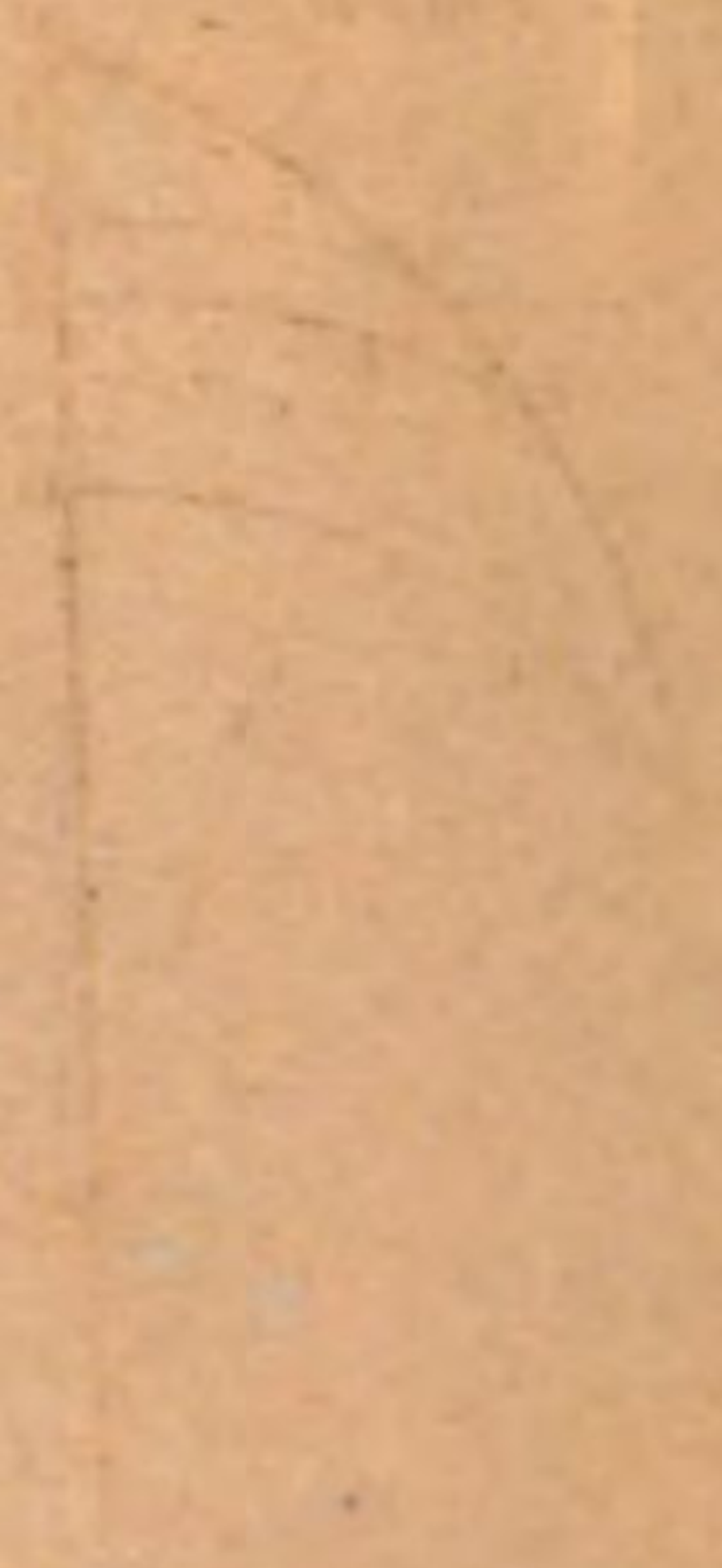
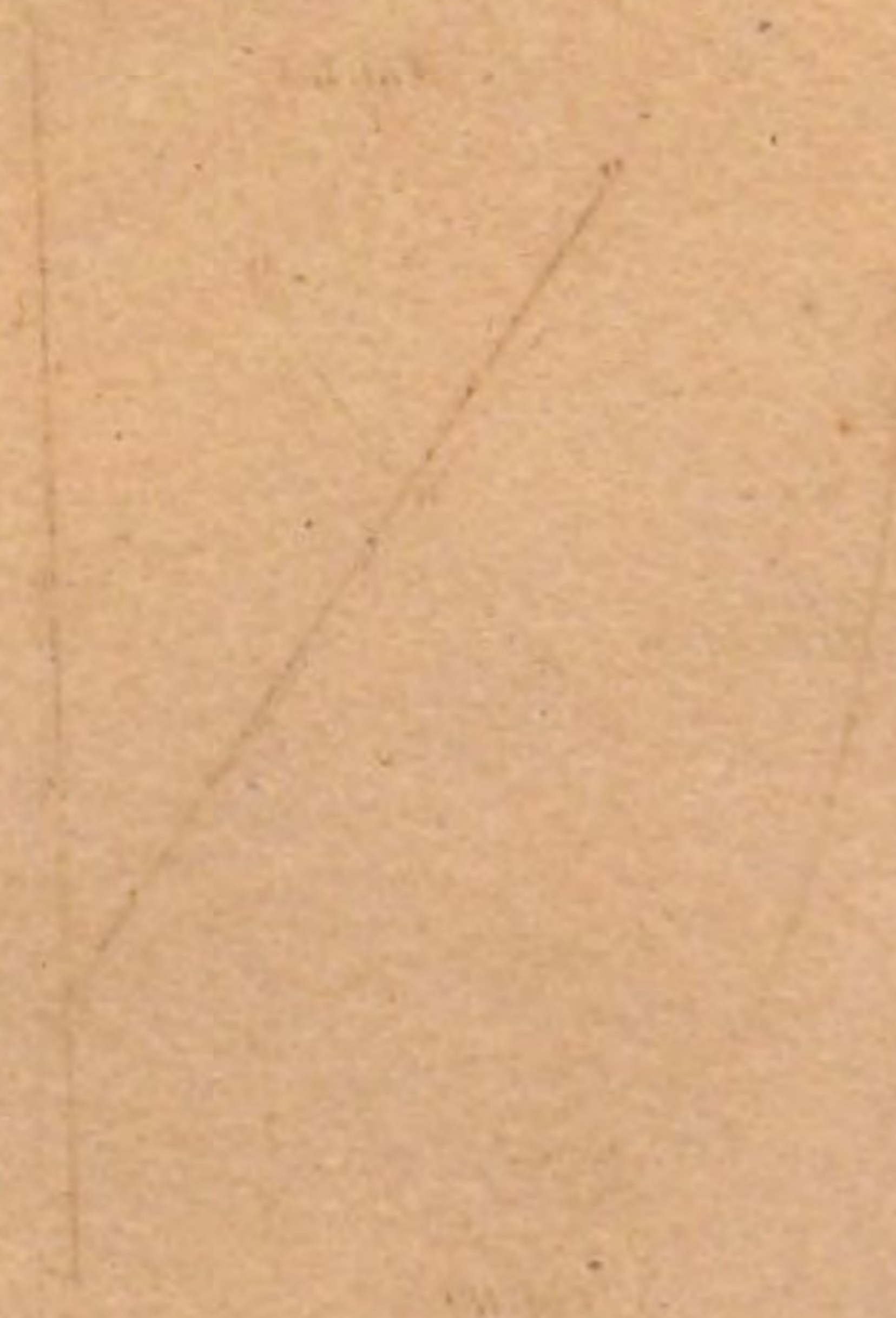
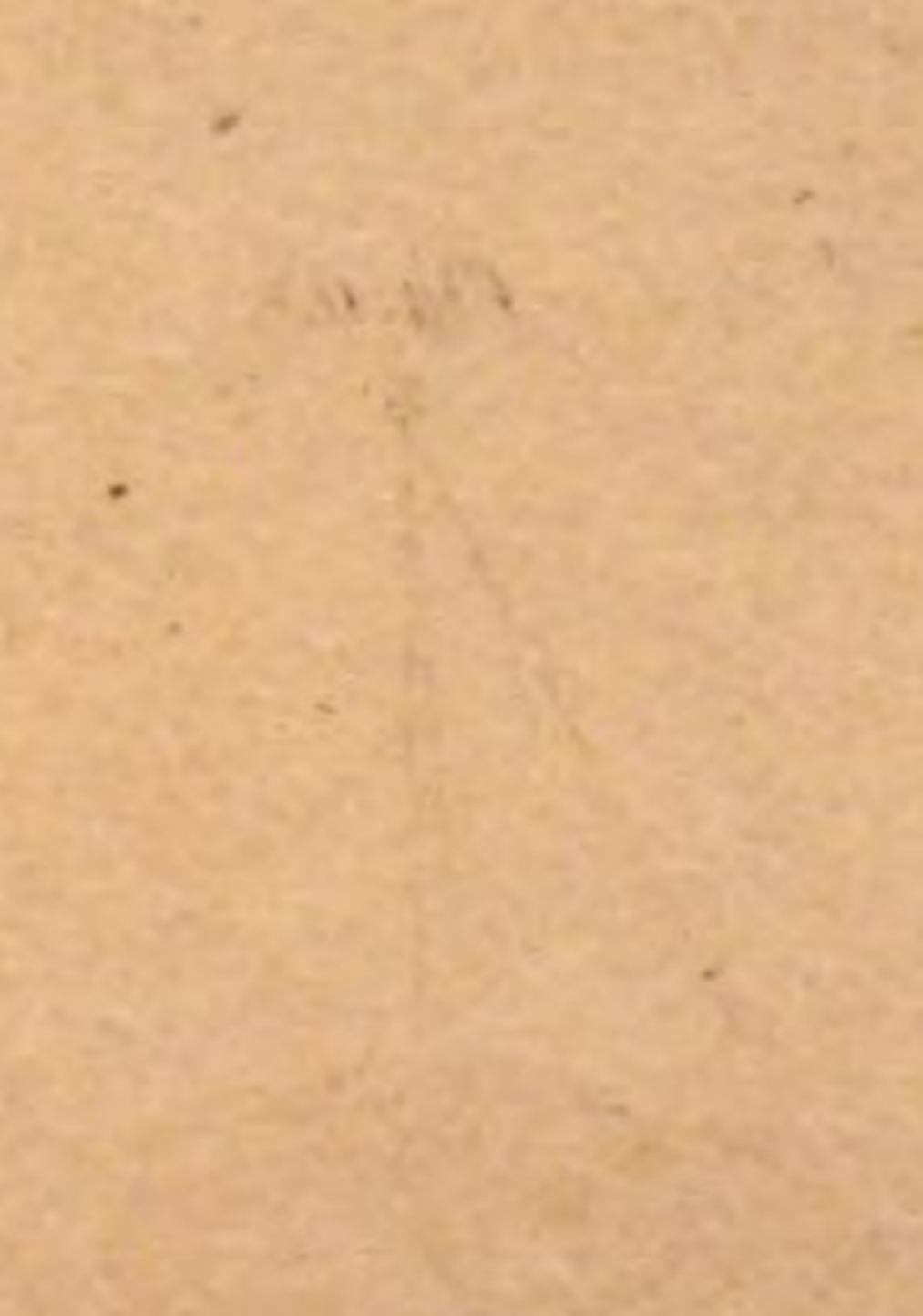


Fig. 117.





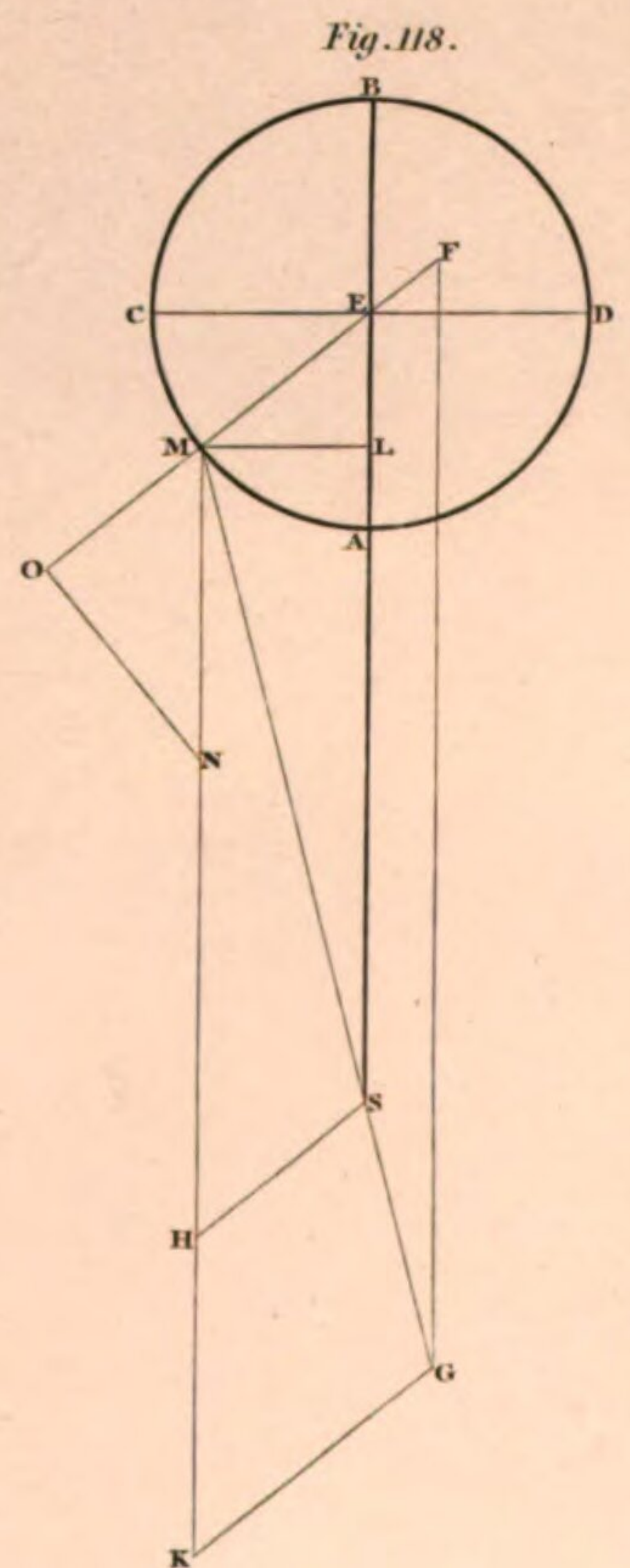
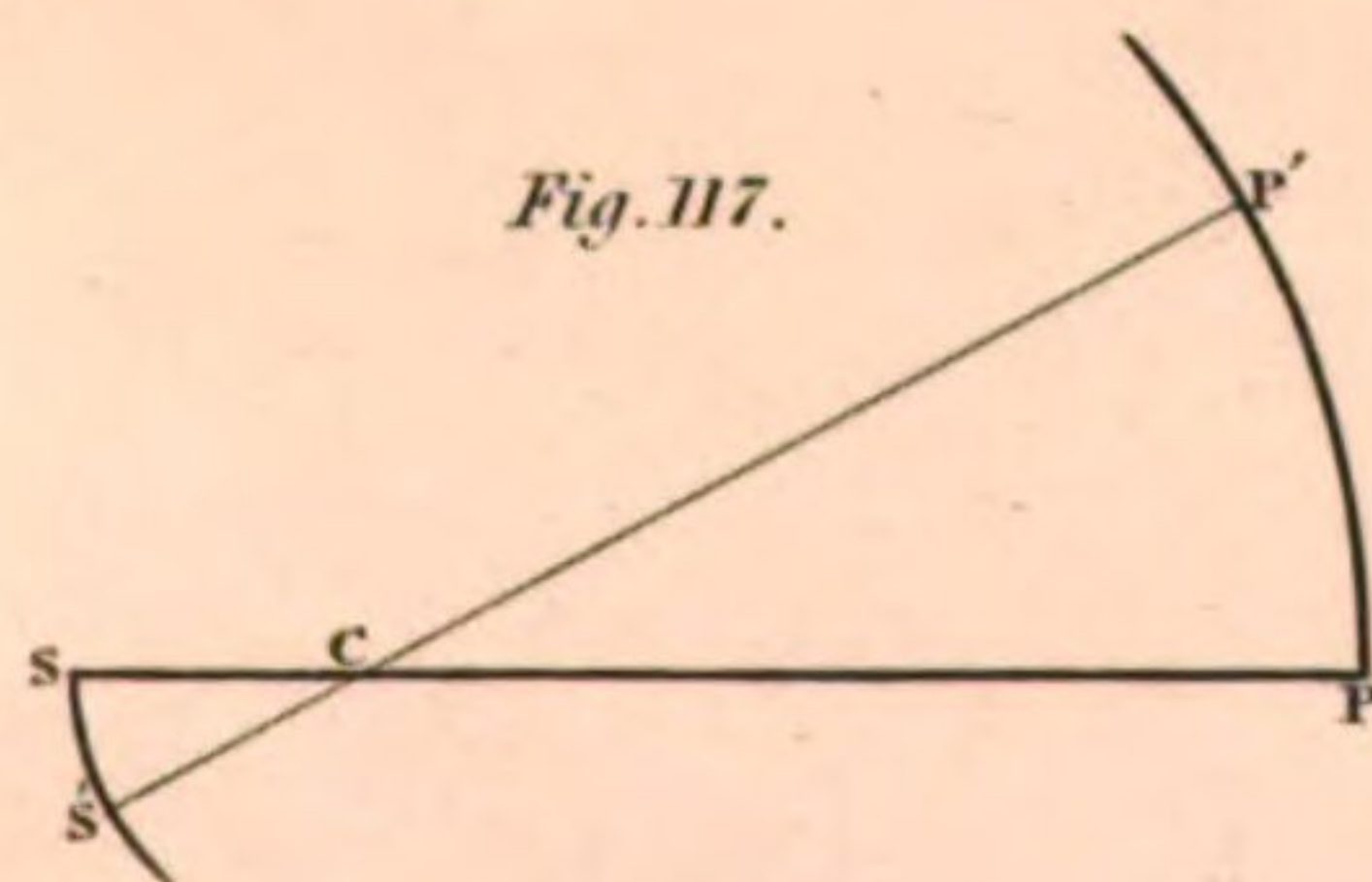
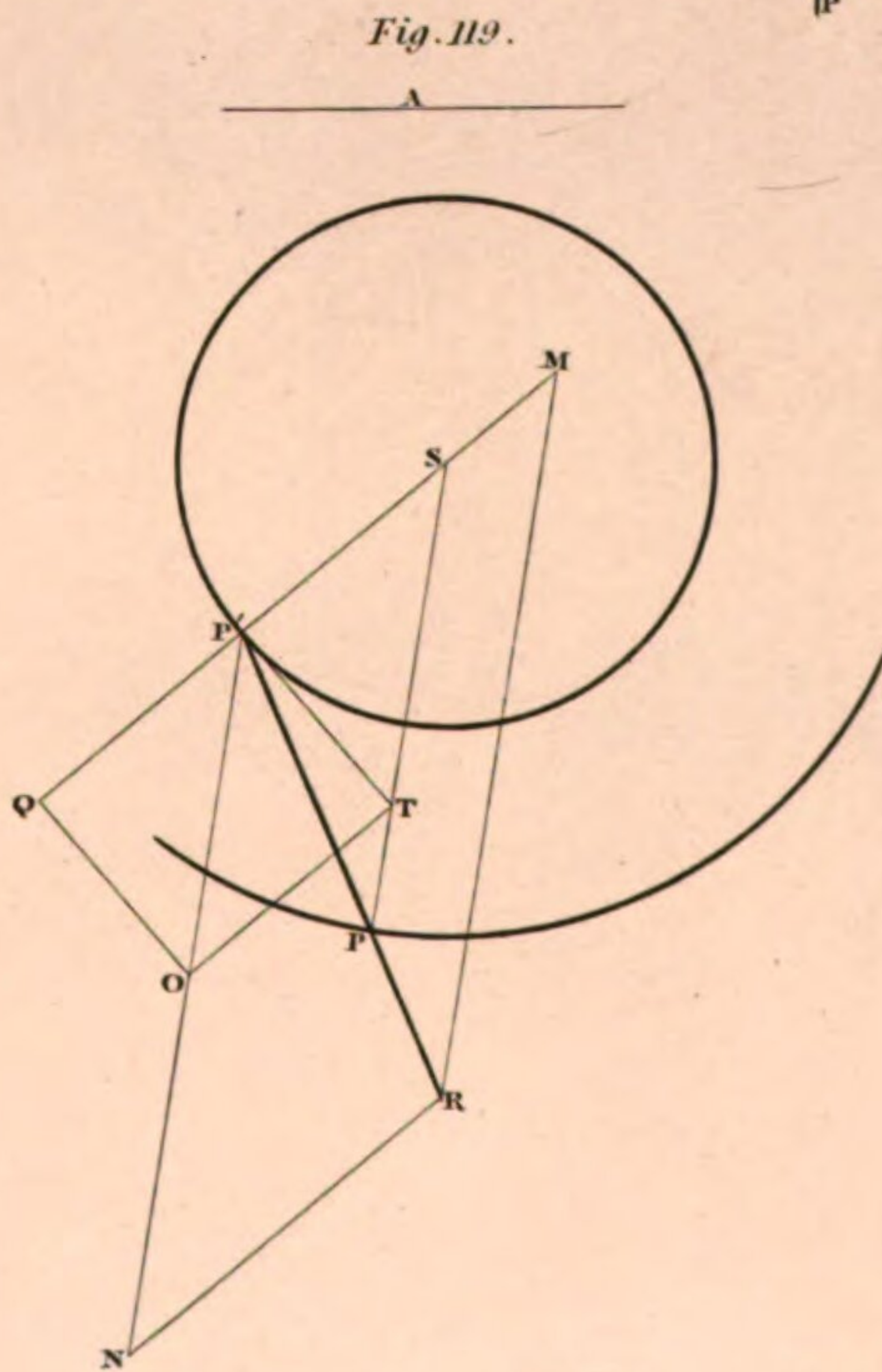
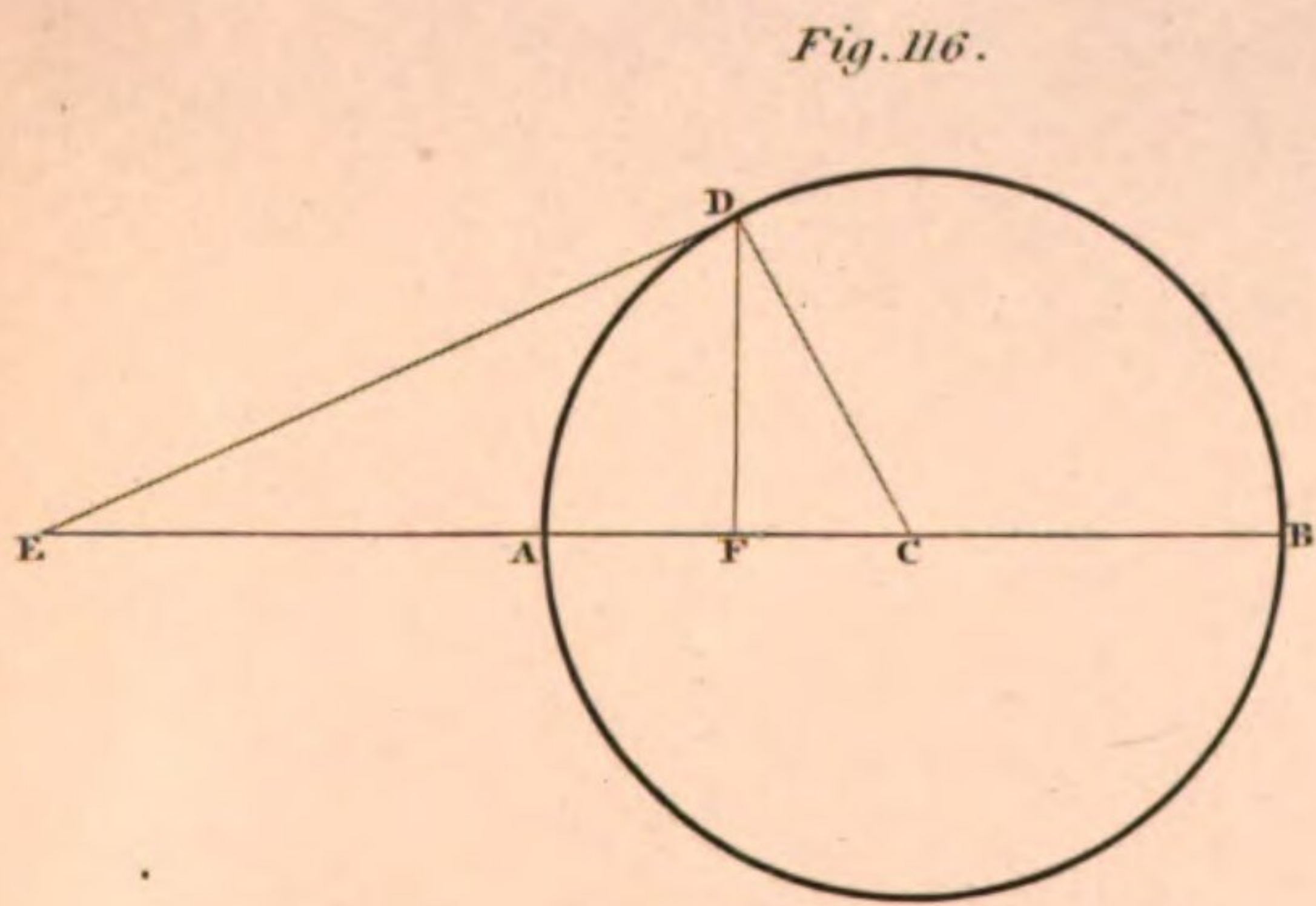
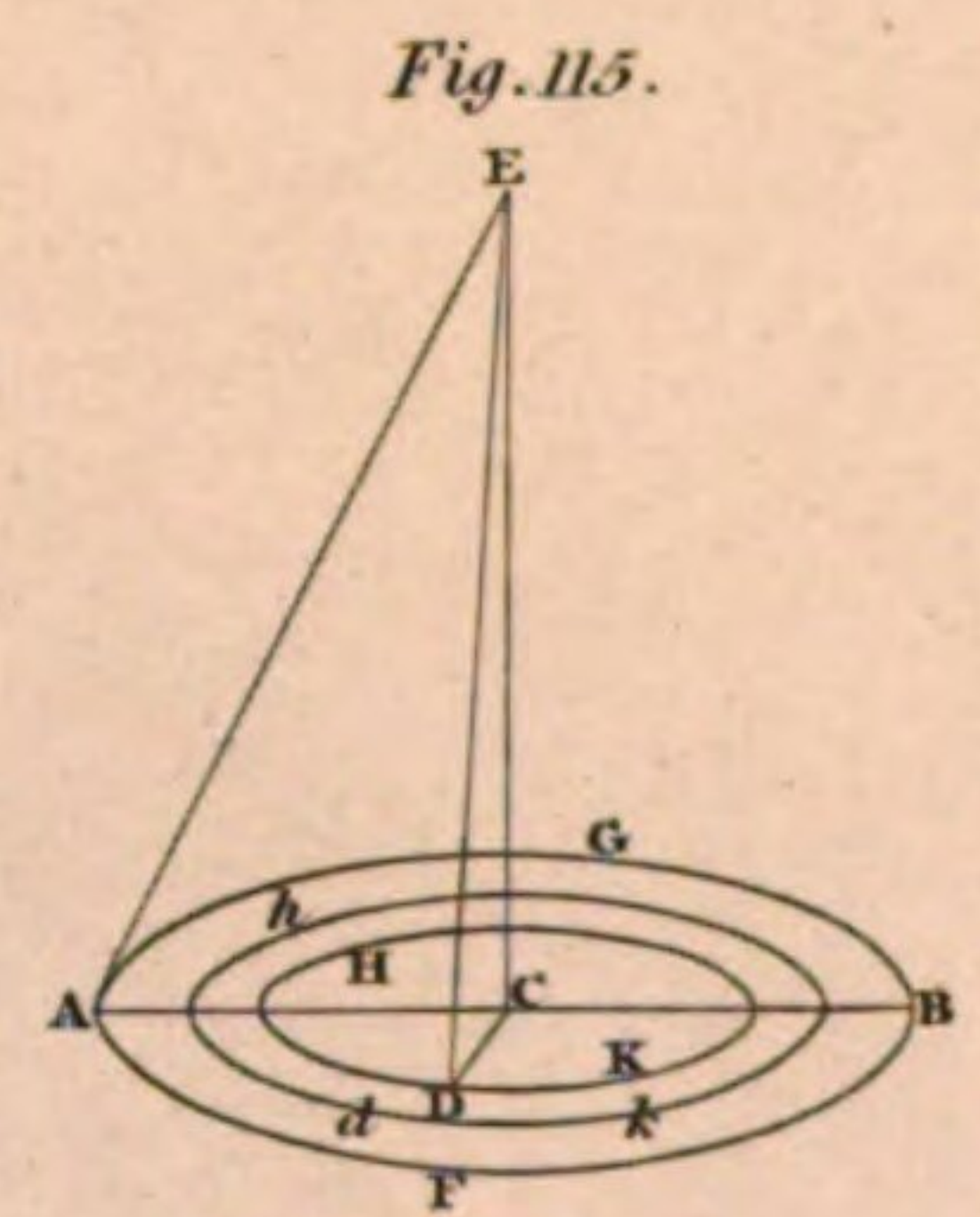
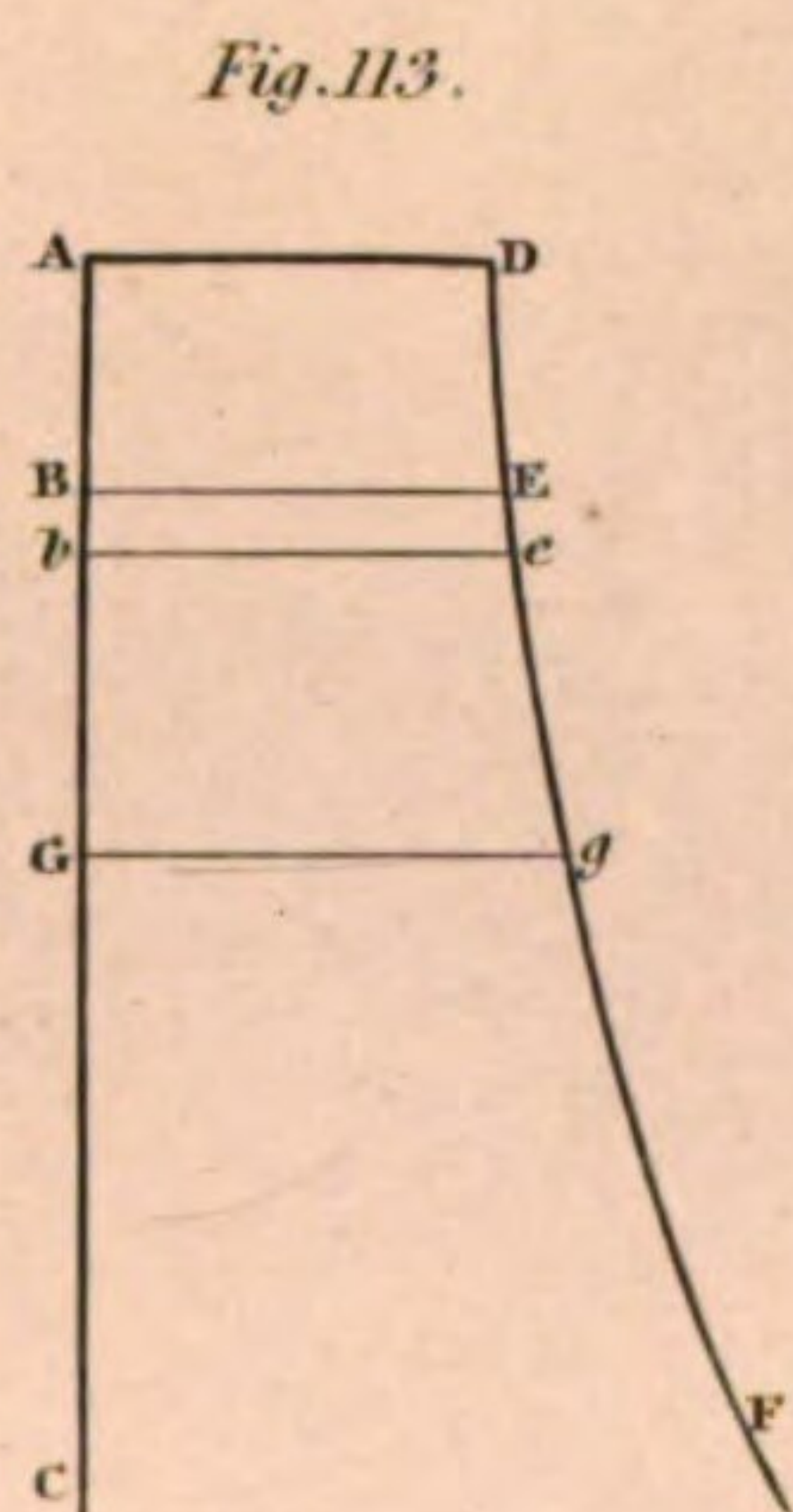
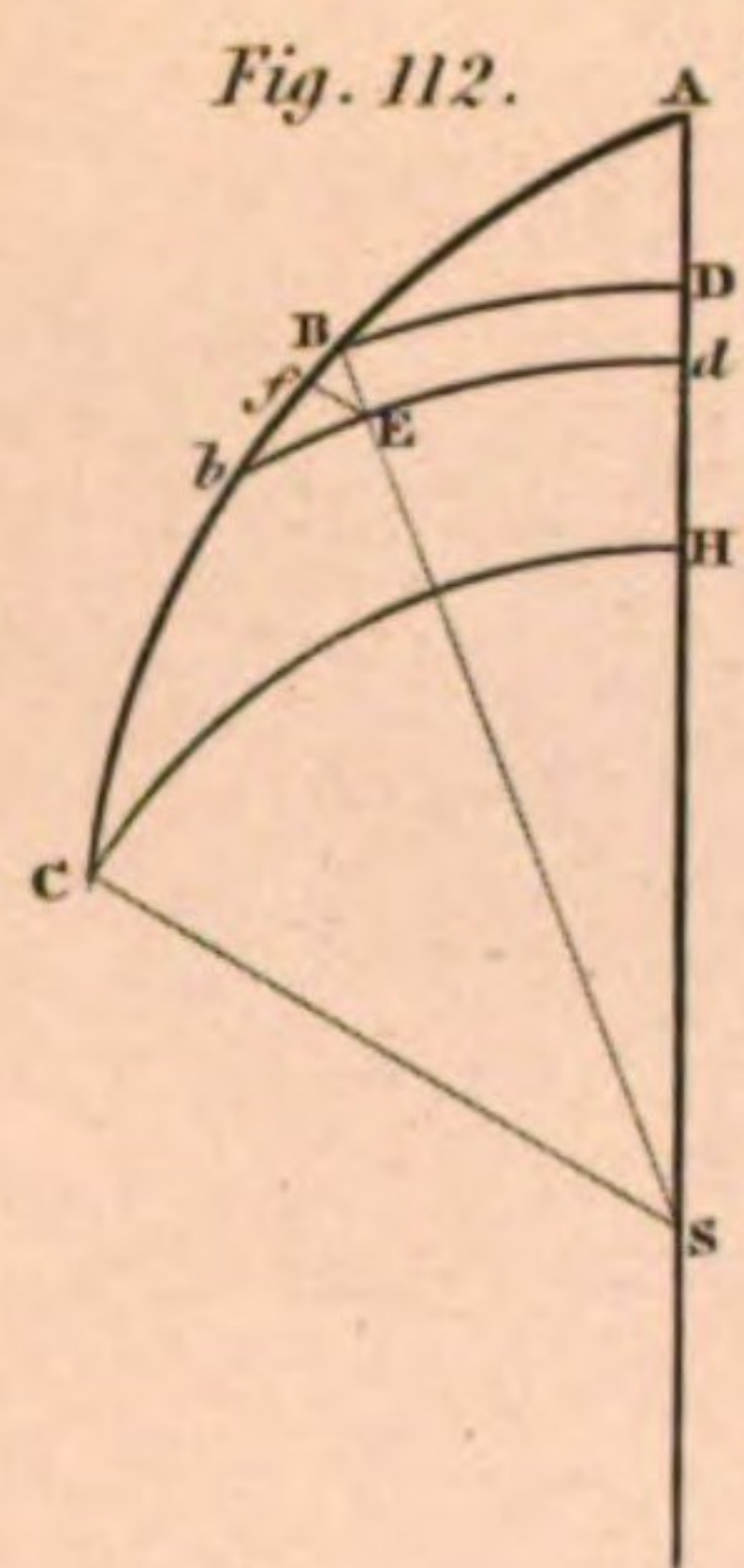
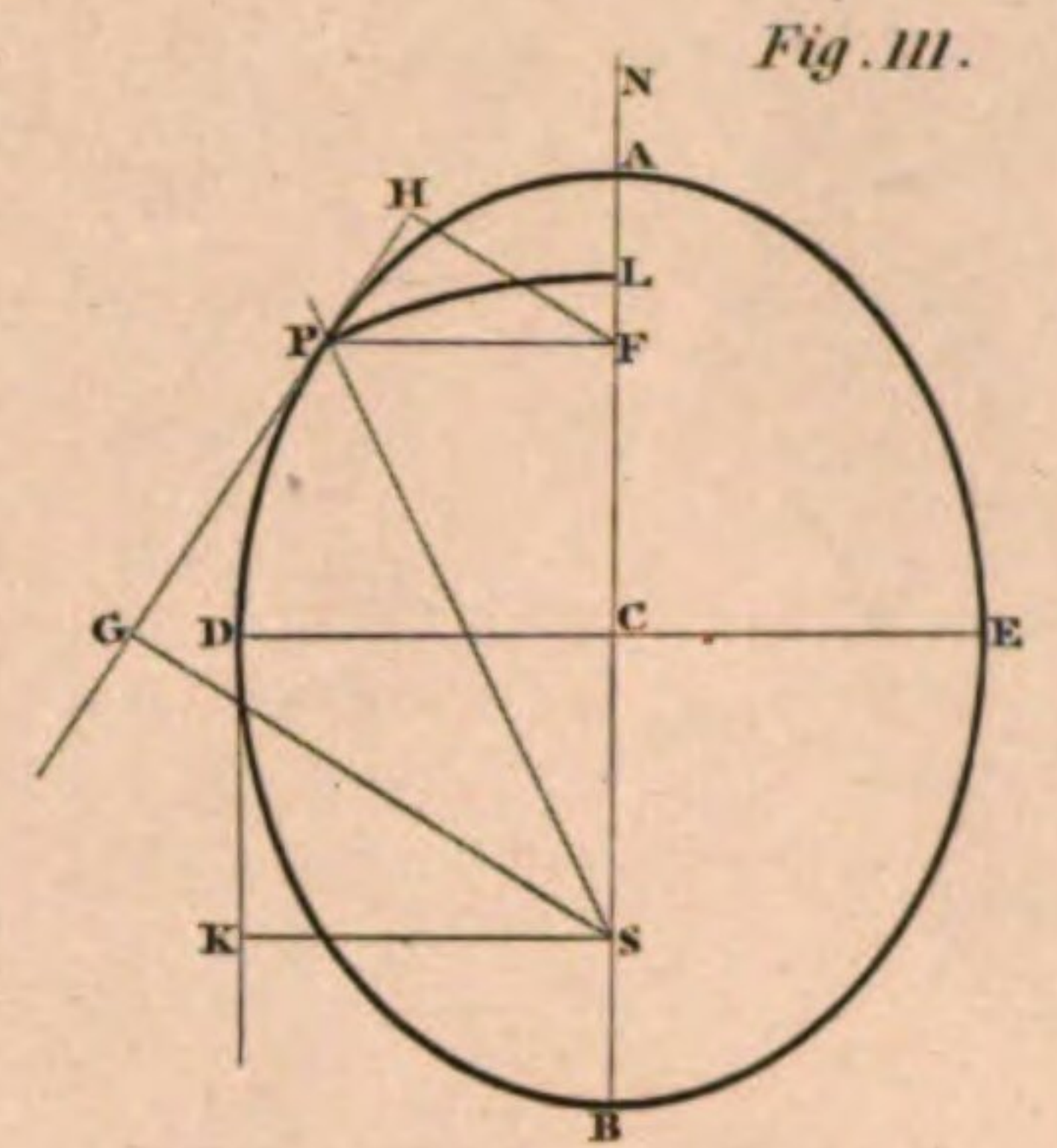
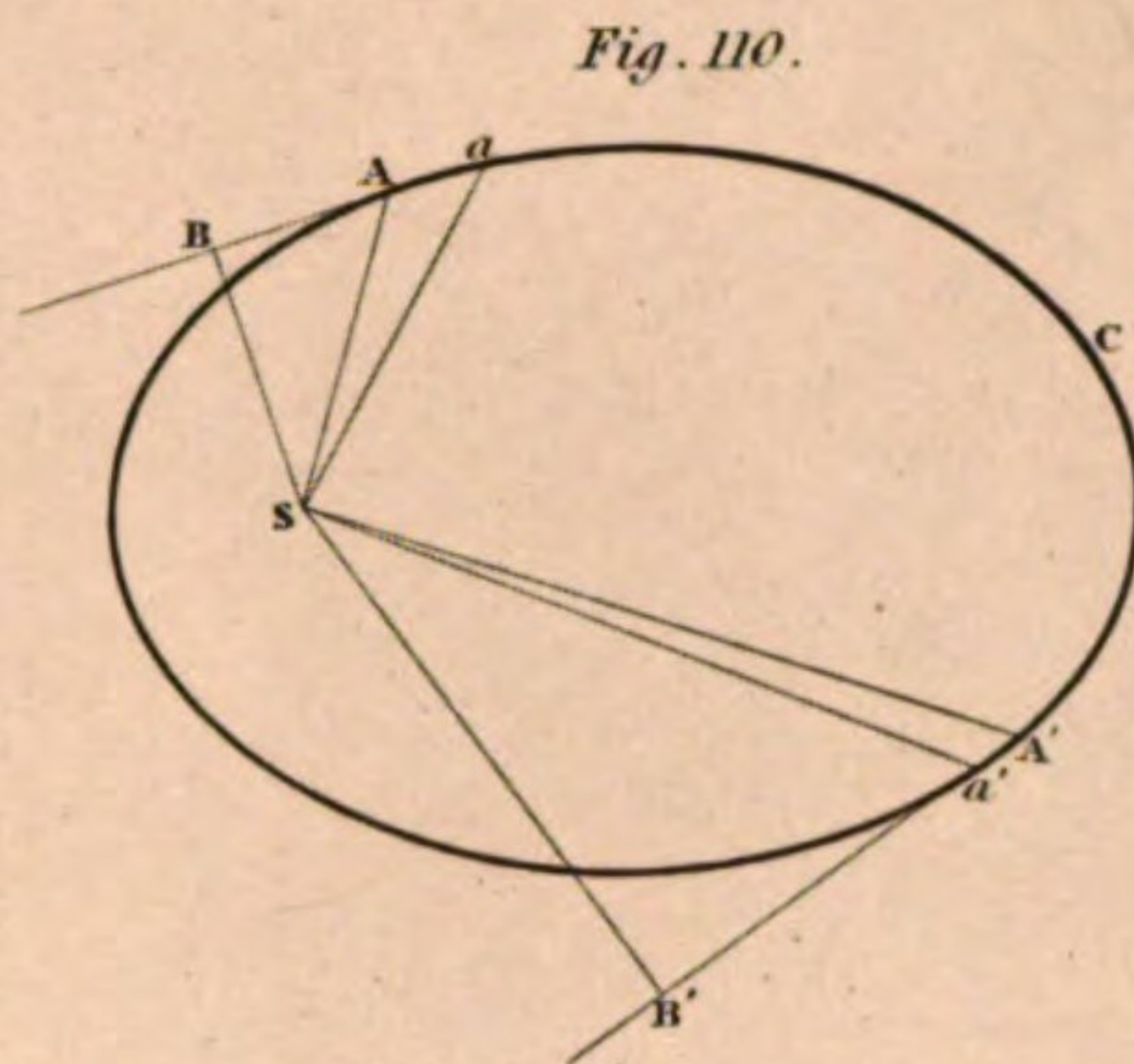
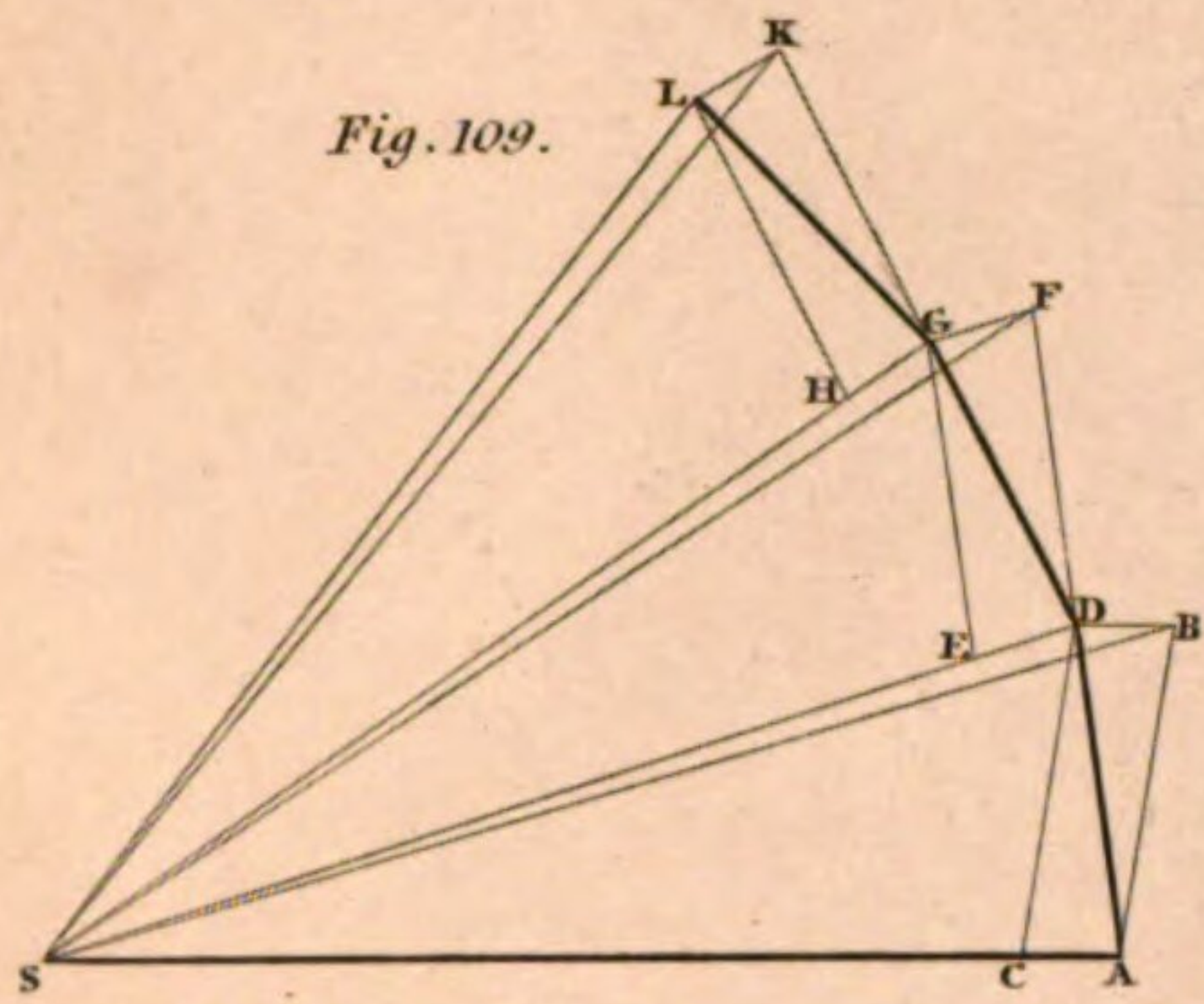


Fig. 127



Fig. 128



Fig. 129



Fig. 130



Fig. 131



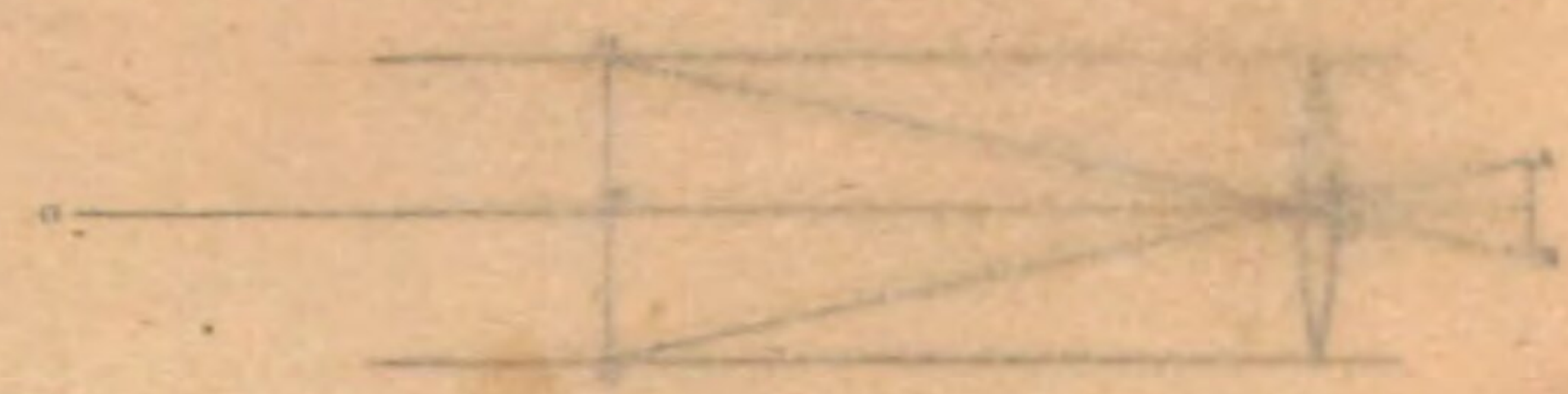
Fig. 132



Fig. 133



Fig. 134



ASTRONOMY.

PLATE XCIII.

Fig. 120.

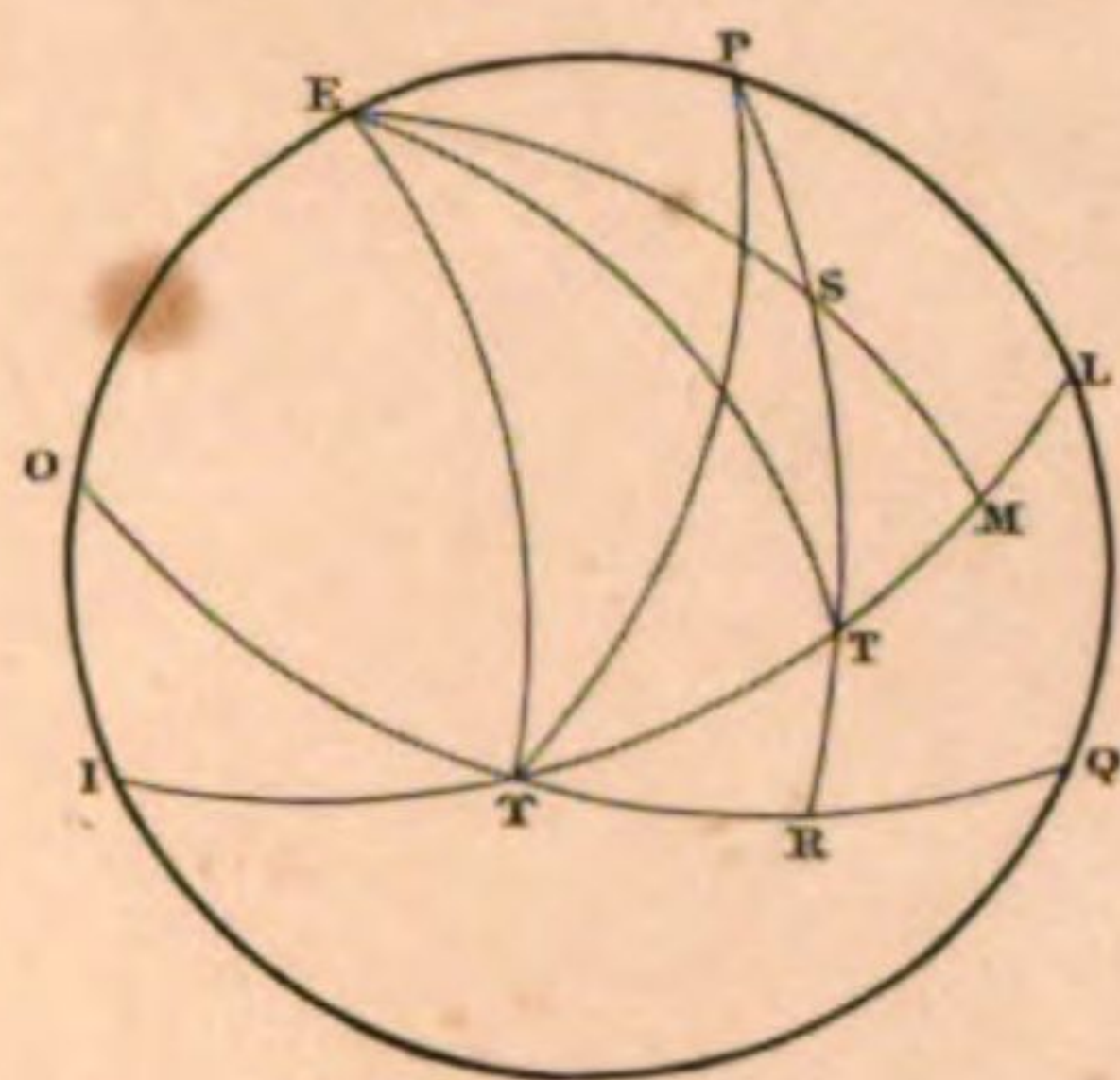


Fig. 121.

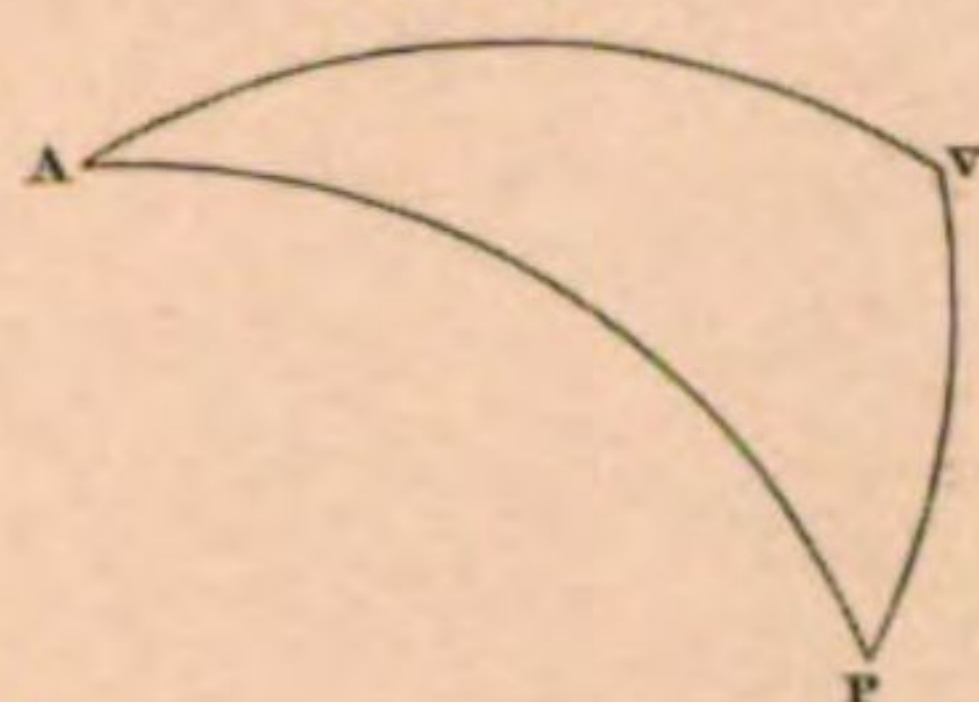


Fig. 122.

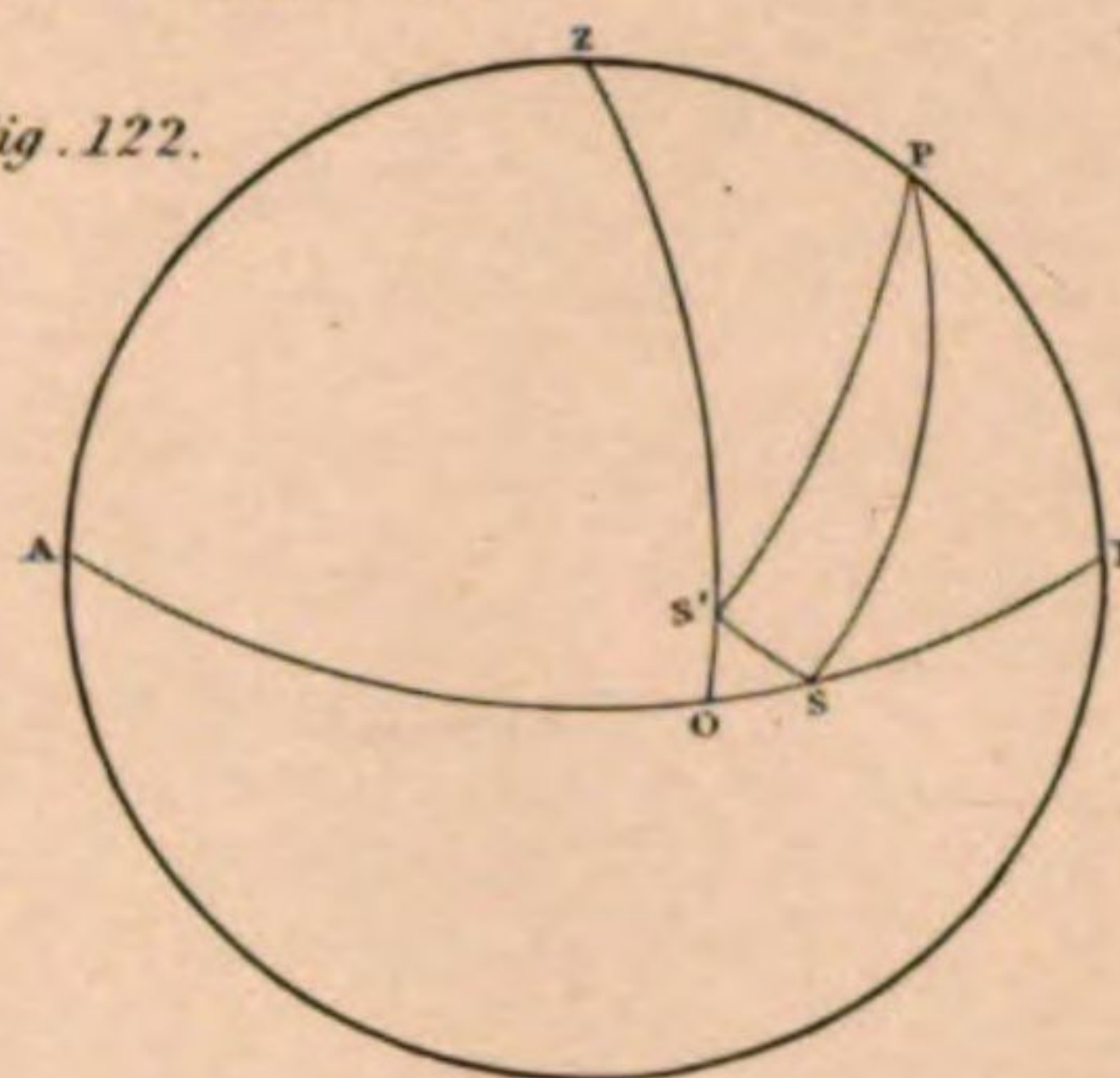


Fig. 123.

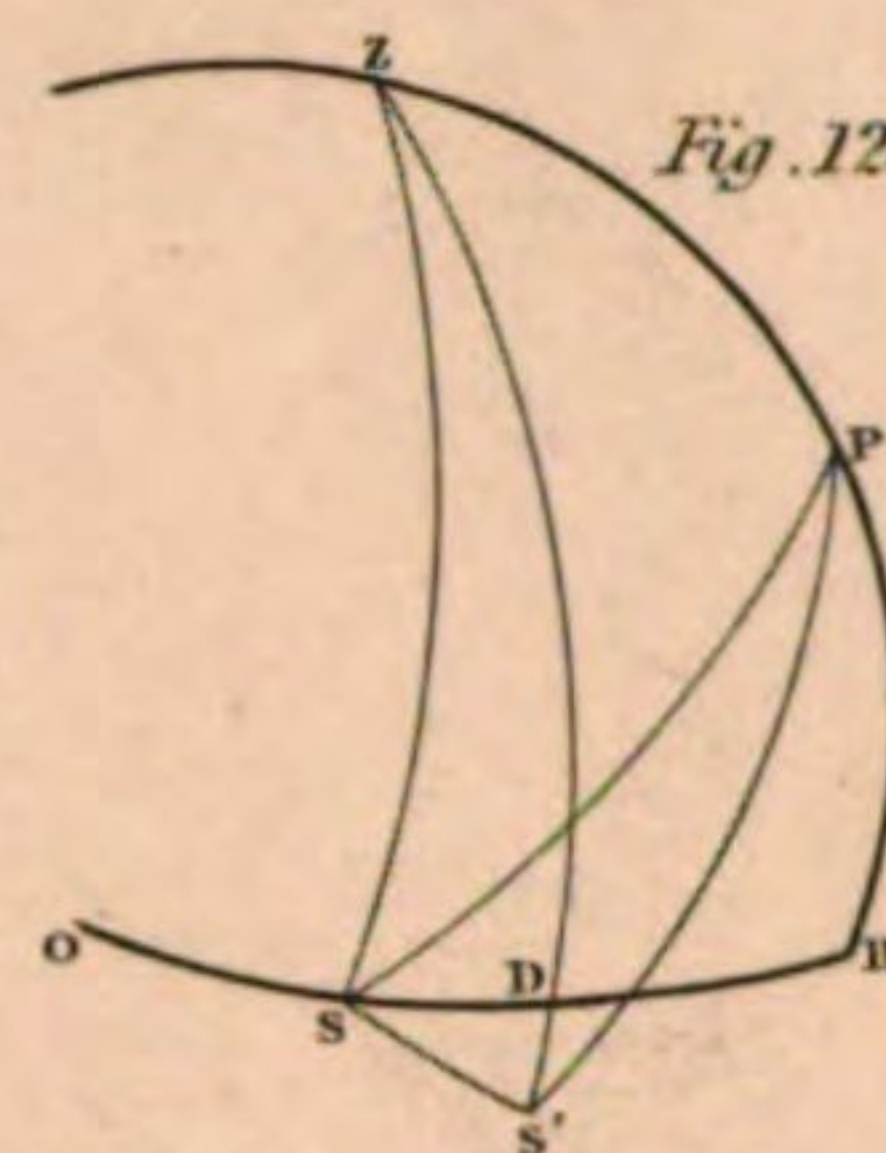


Fig. 124.

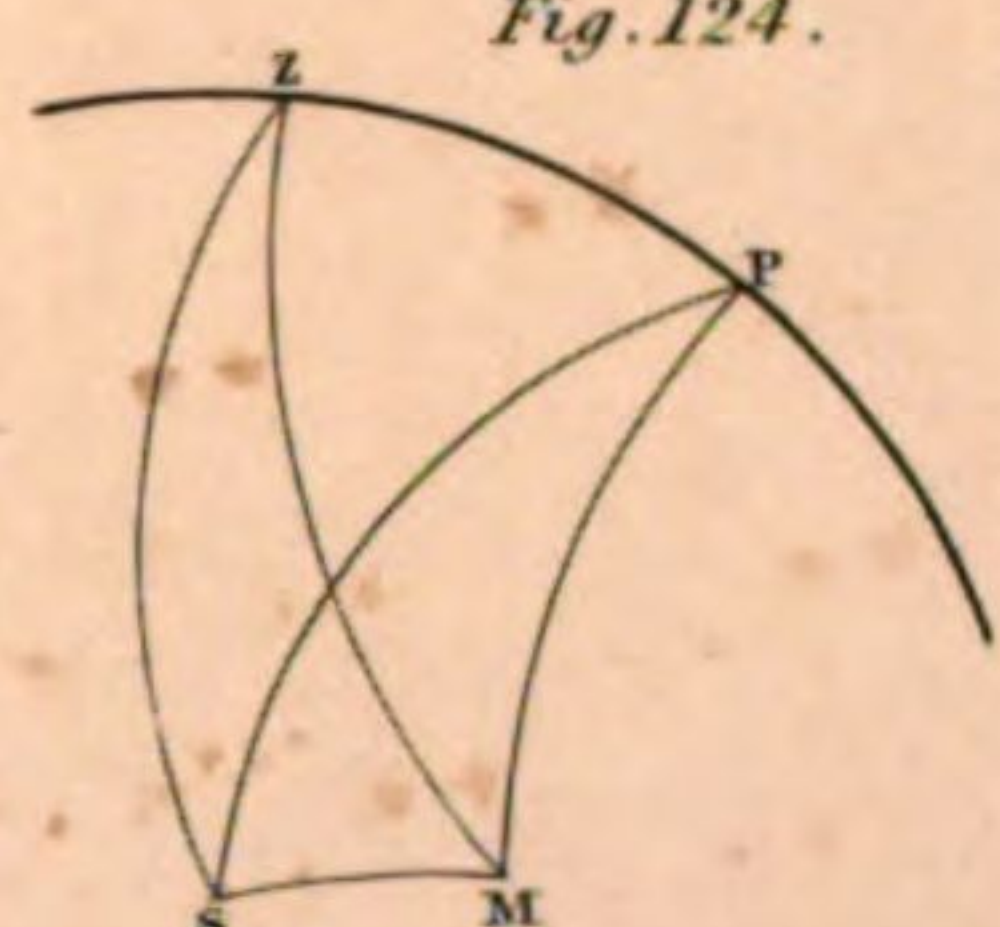


Fig. 125.

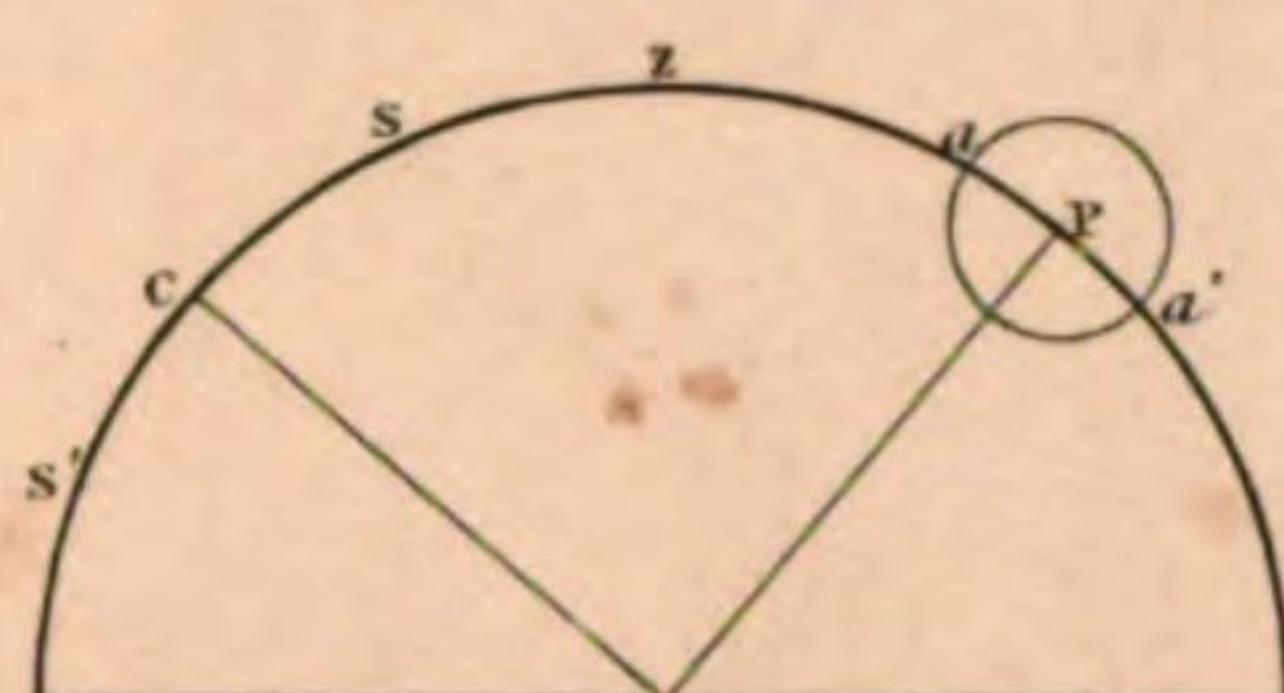


Fig. 126.

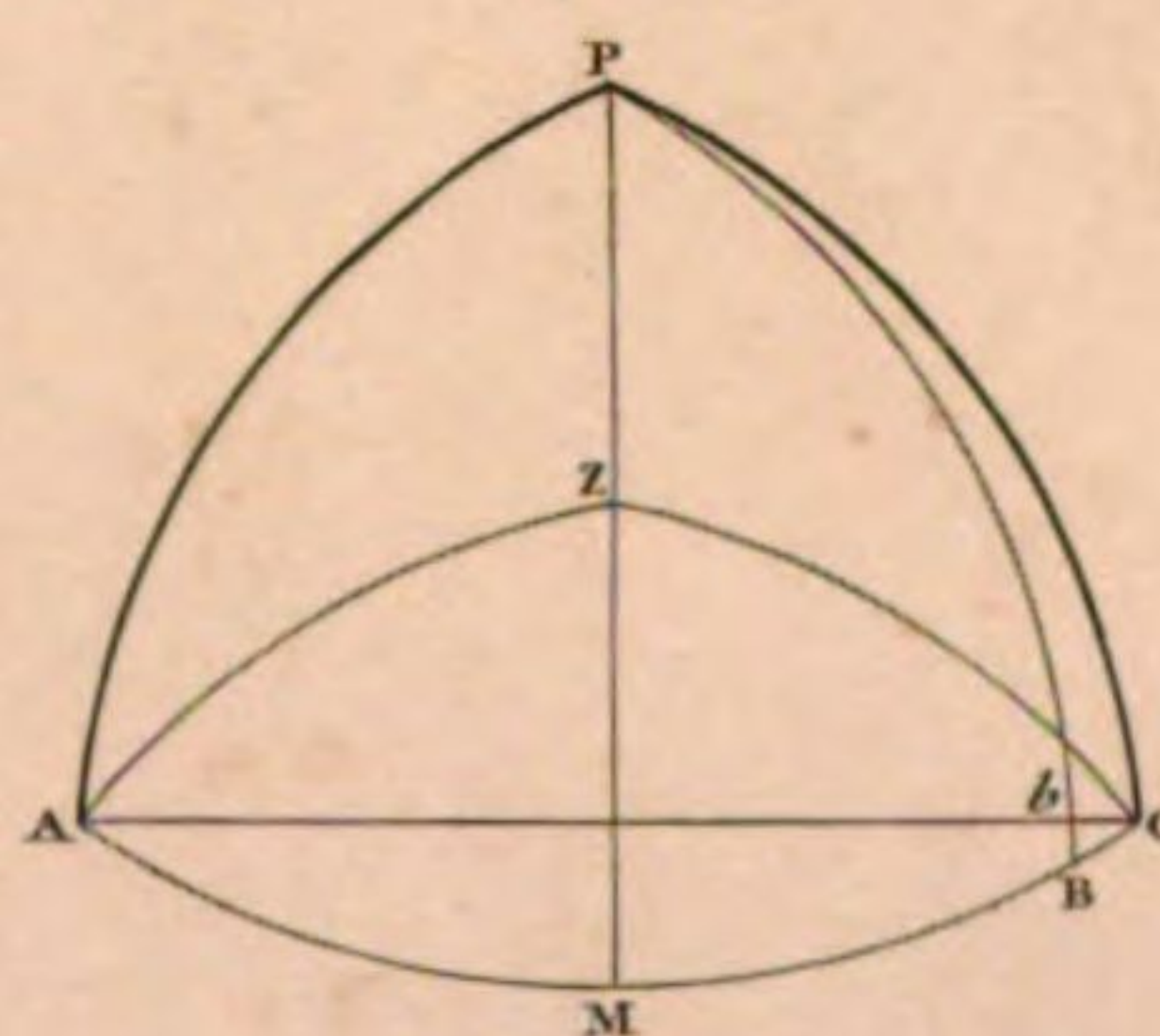


Fig. 127.

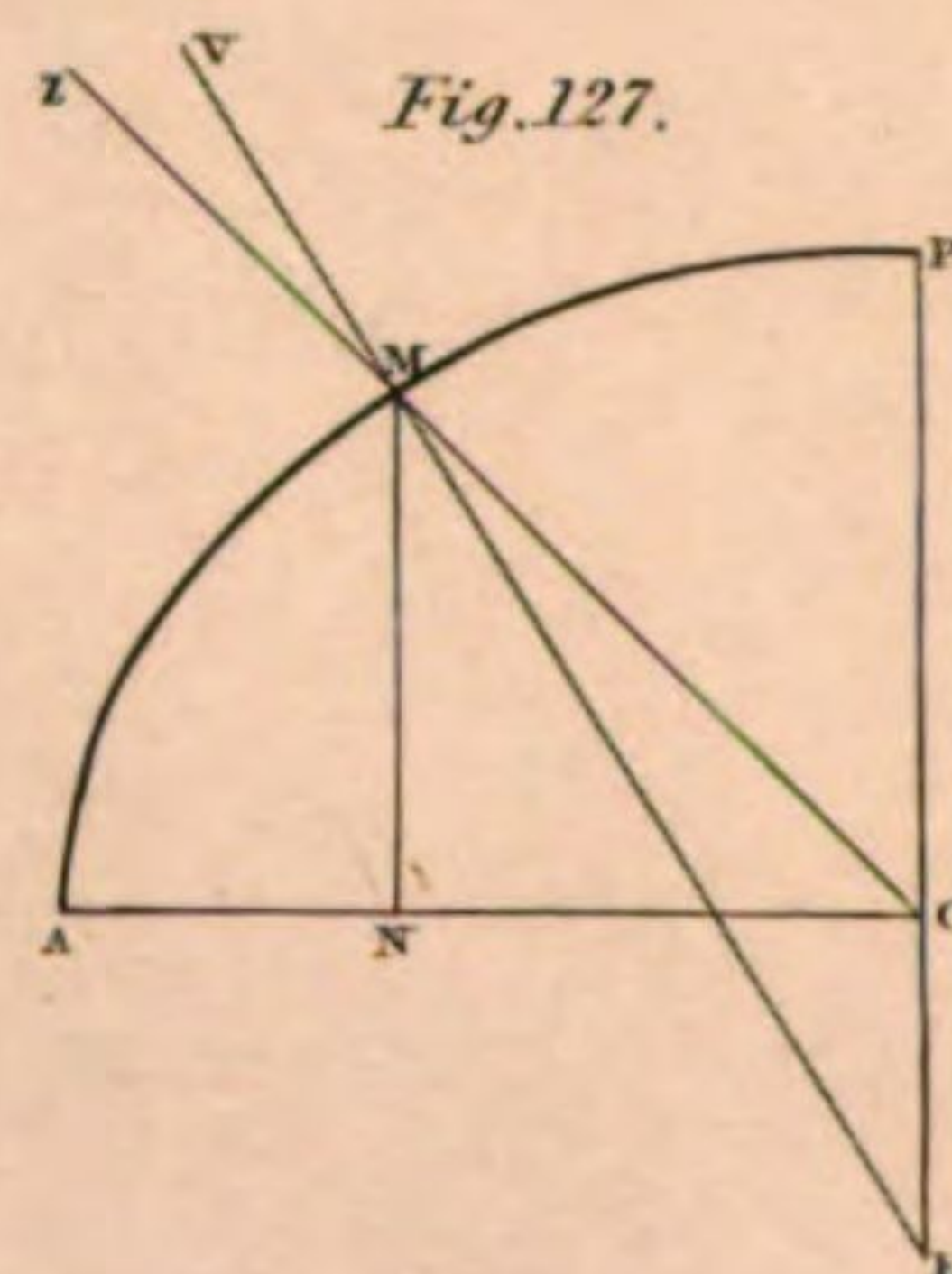


Fig. 129.

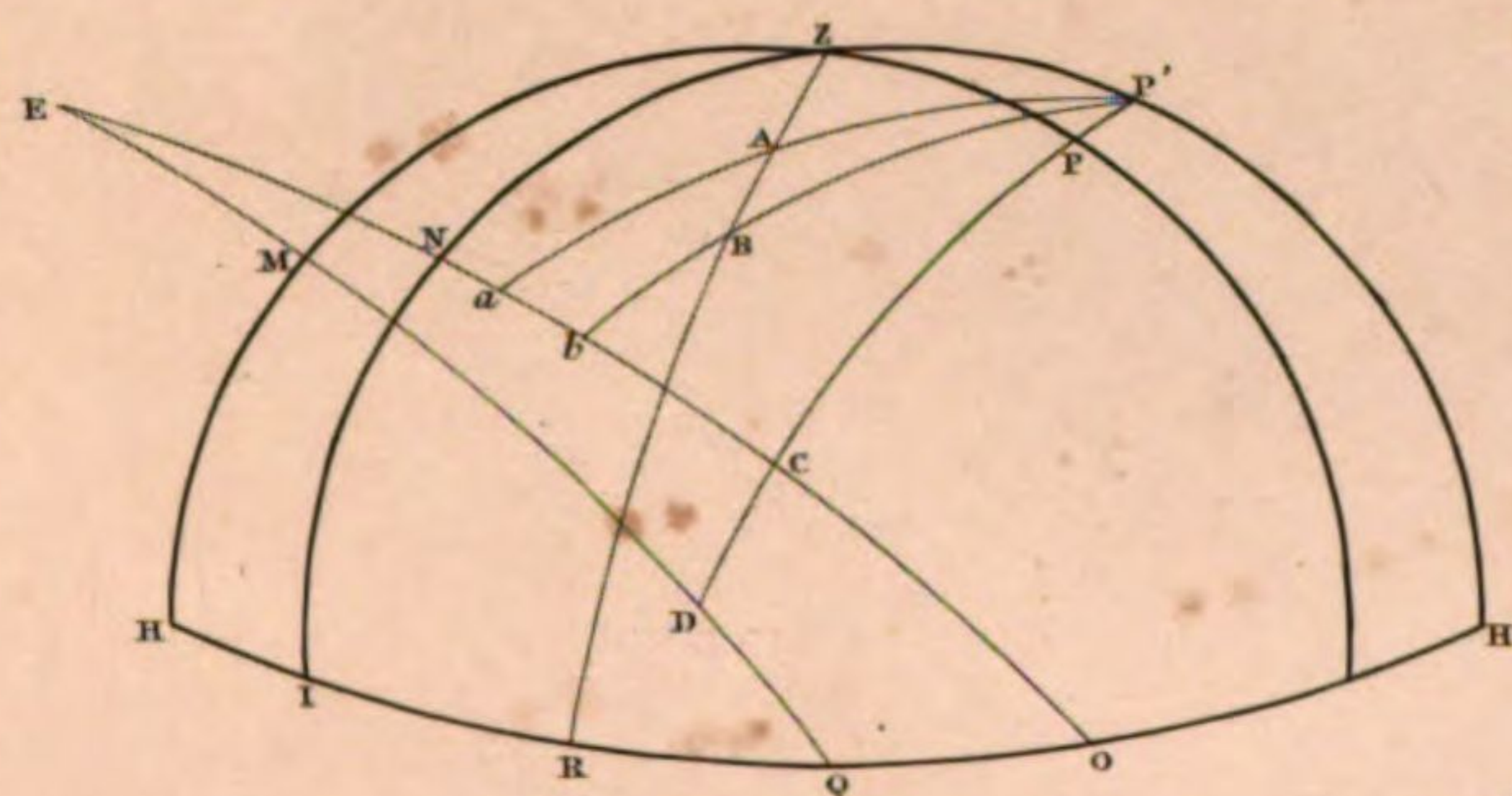


Fig. 128.

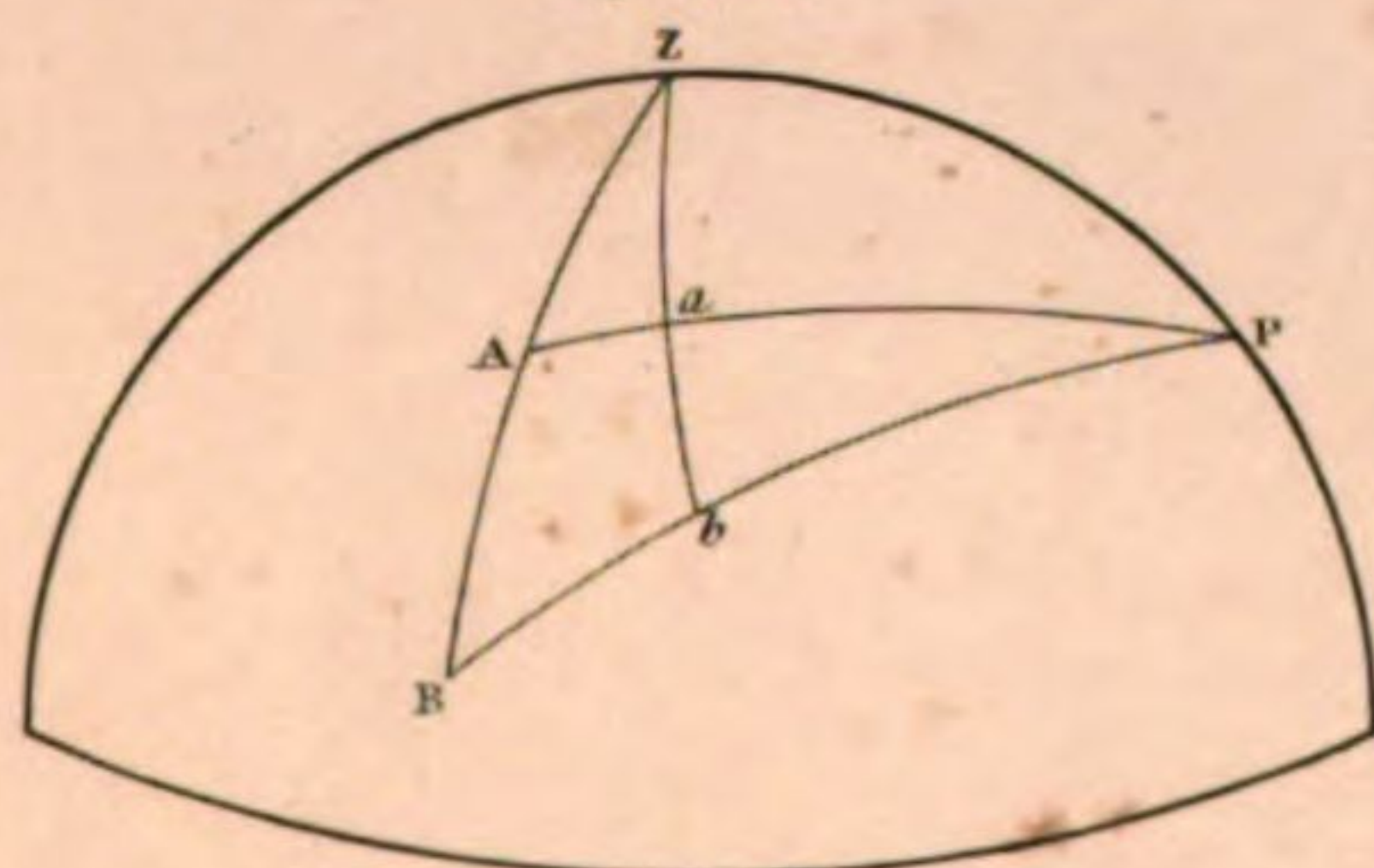


Fig. 130.

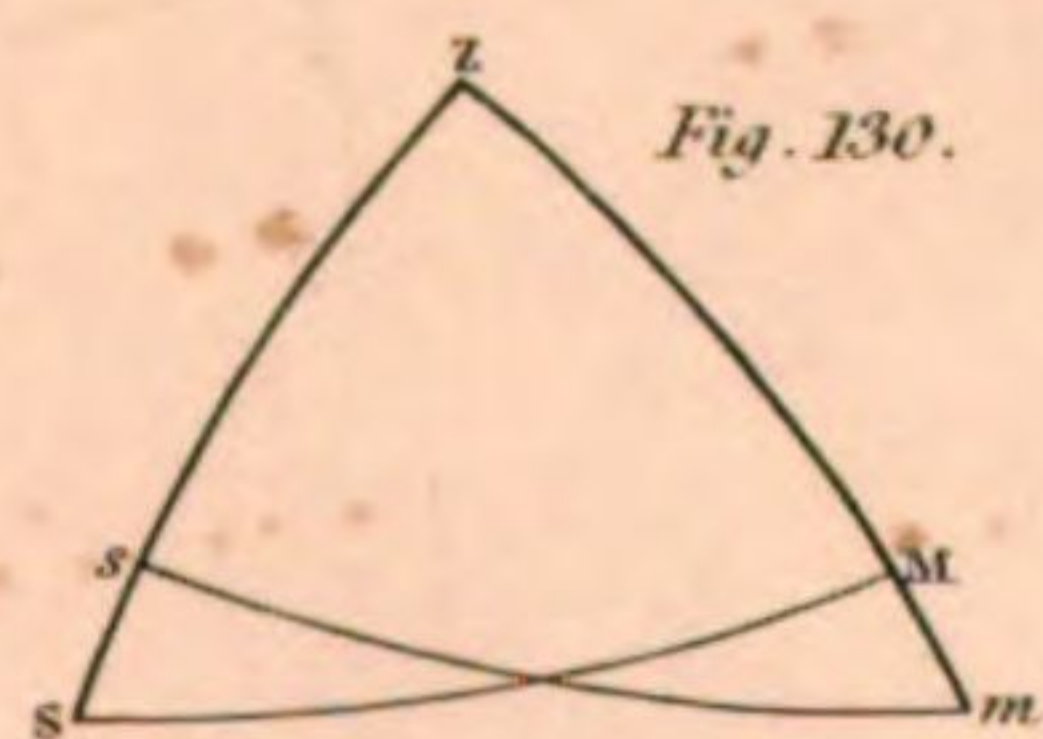


Fig. 134.

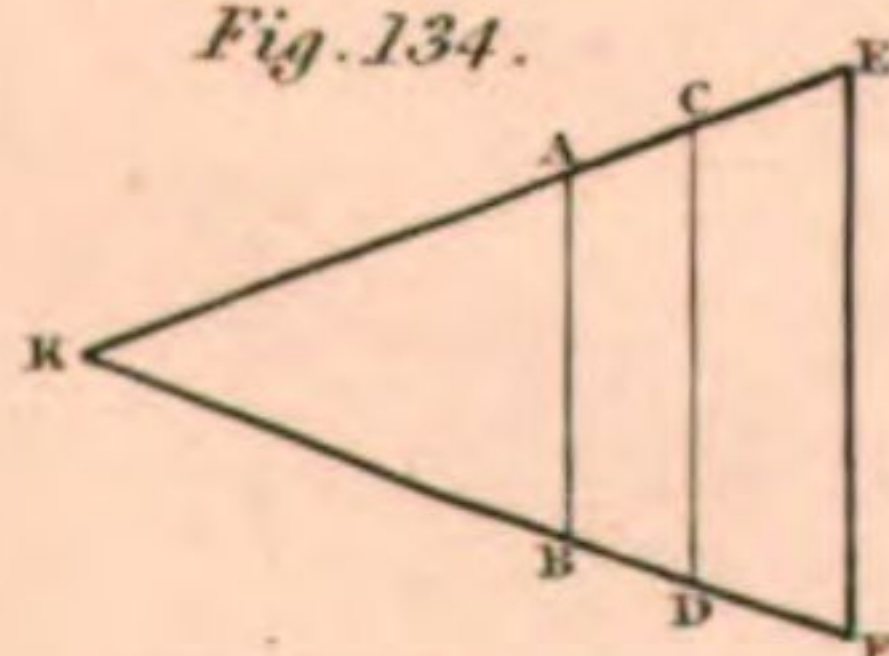


Fig. 131.

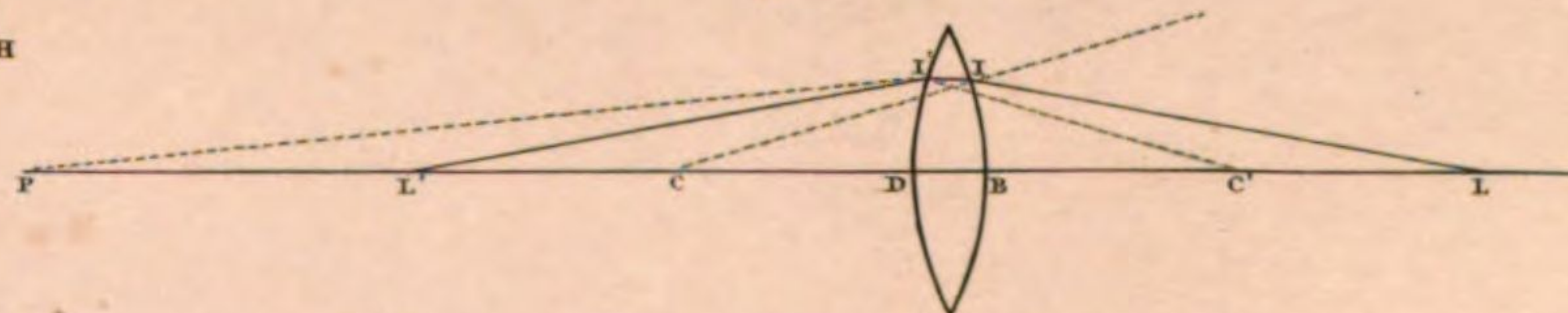


Fig. 132.

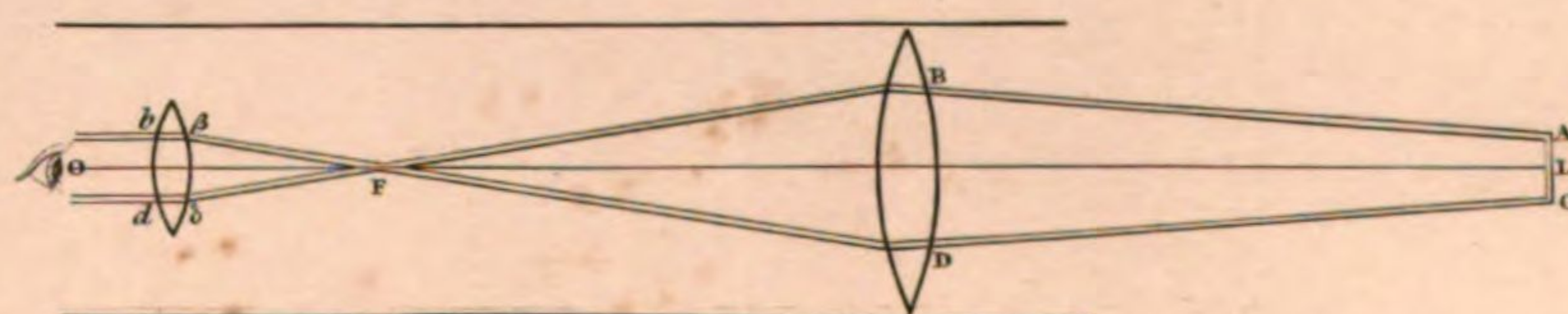


Fig. 133.

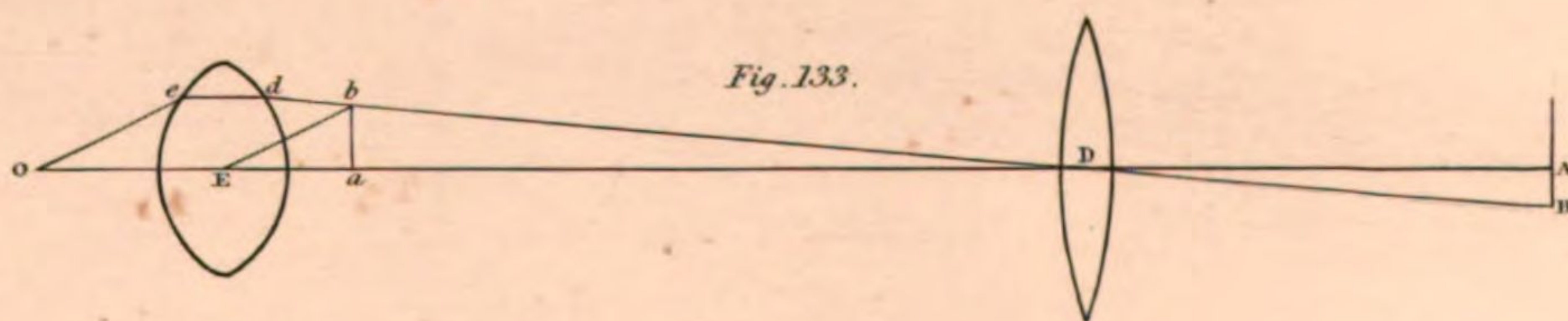


Fig. 135.

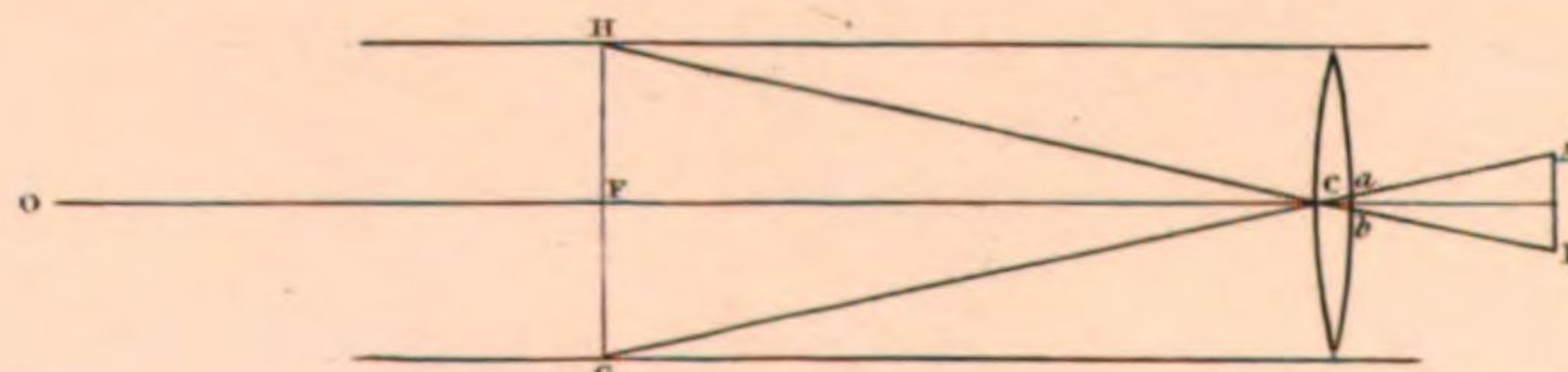


Diagram of the Annular Eclipse of the Sun, 13th Sep. 1830.
Fig. 136.

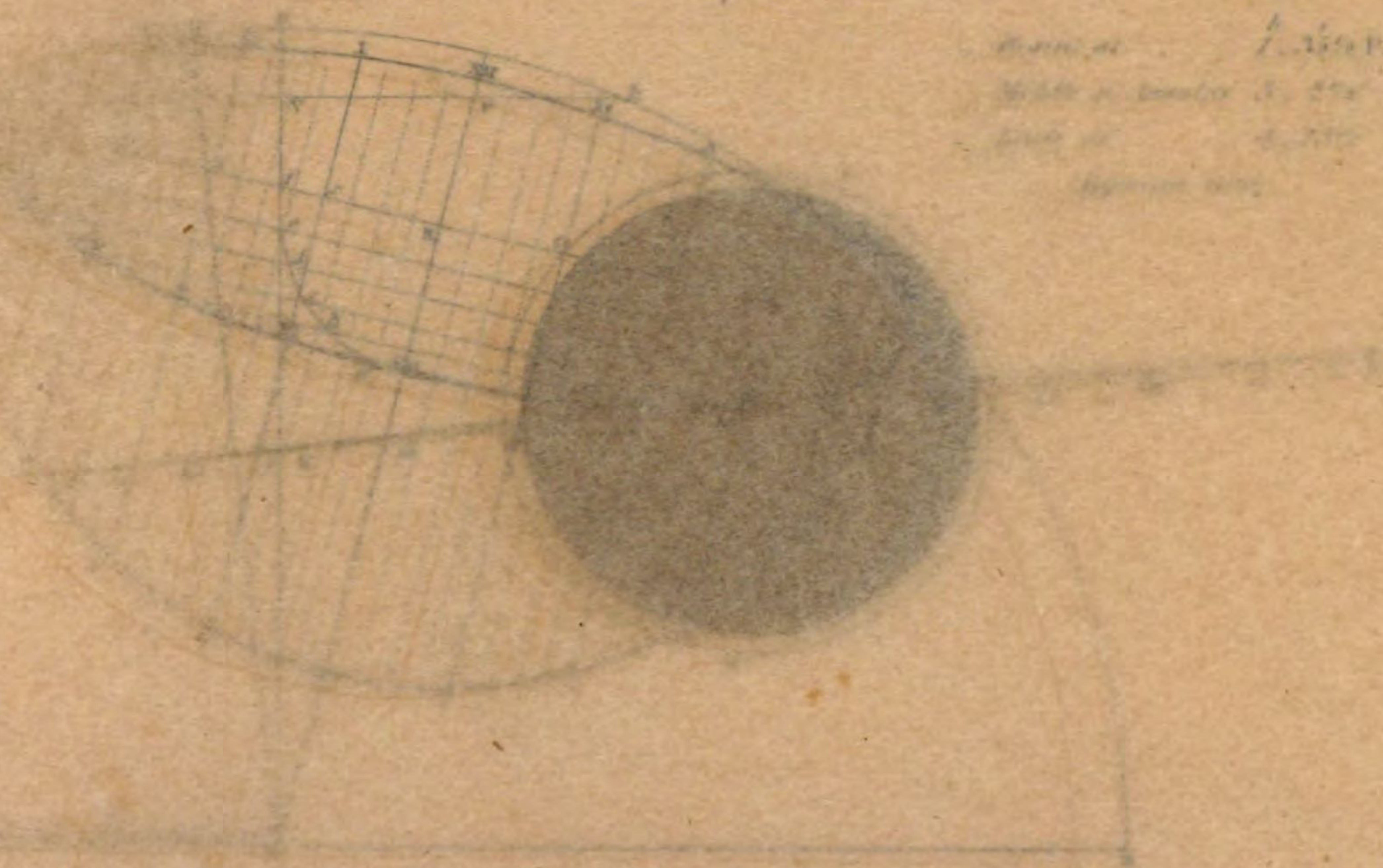
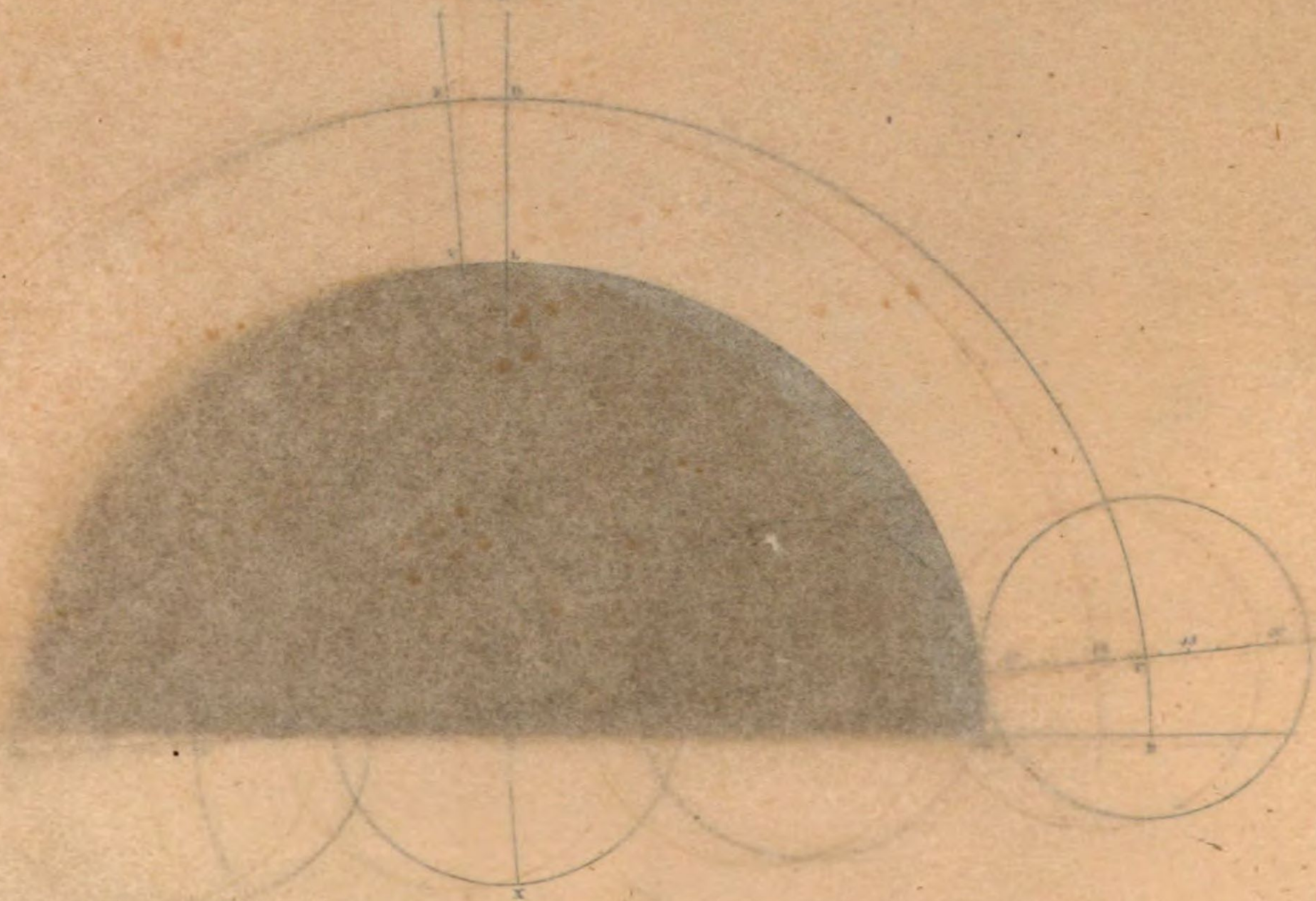


Diagram of the Lunar Eclipse, 1st Sep. 1830.
Fig. 137.



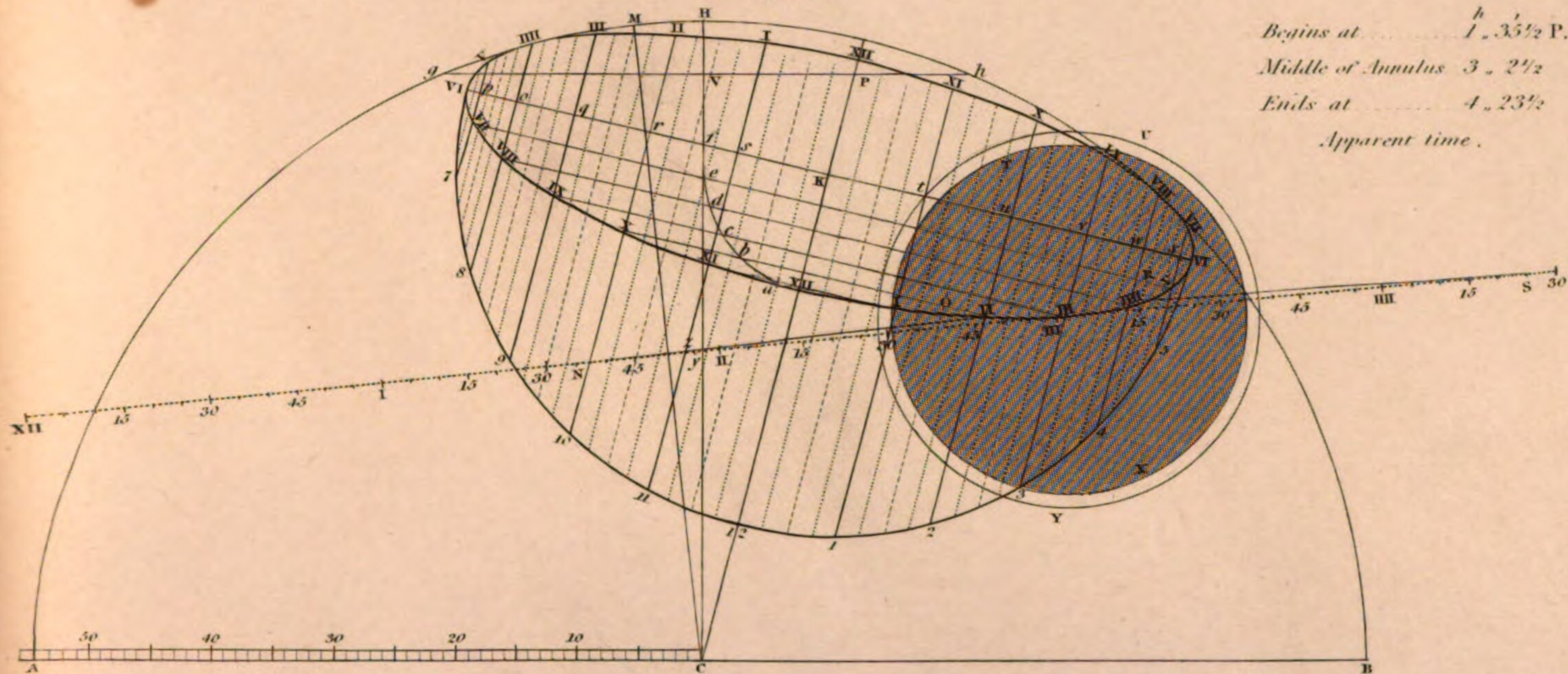
PLAN

SECTION



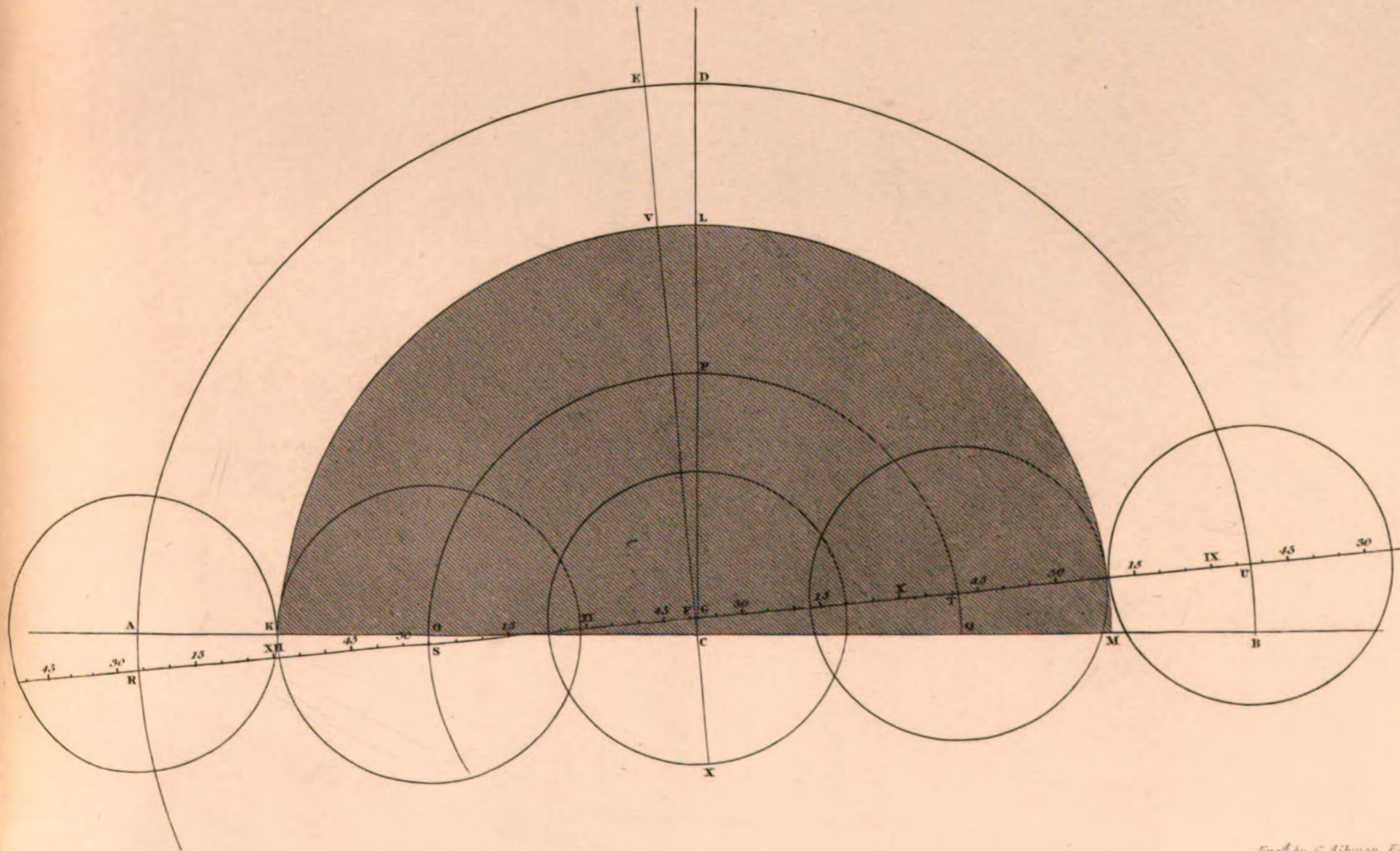
Projection for Edinburgh of the Annular Eclipse of the Sun, 15th May, 1836.

Fig. 136.



Projection of the Lunar Eclipse 2^d Sep^r 1830.

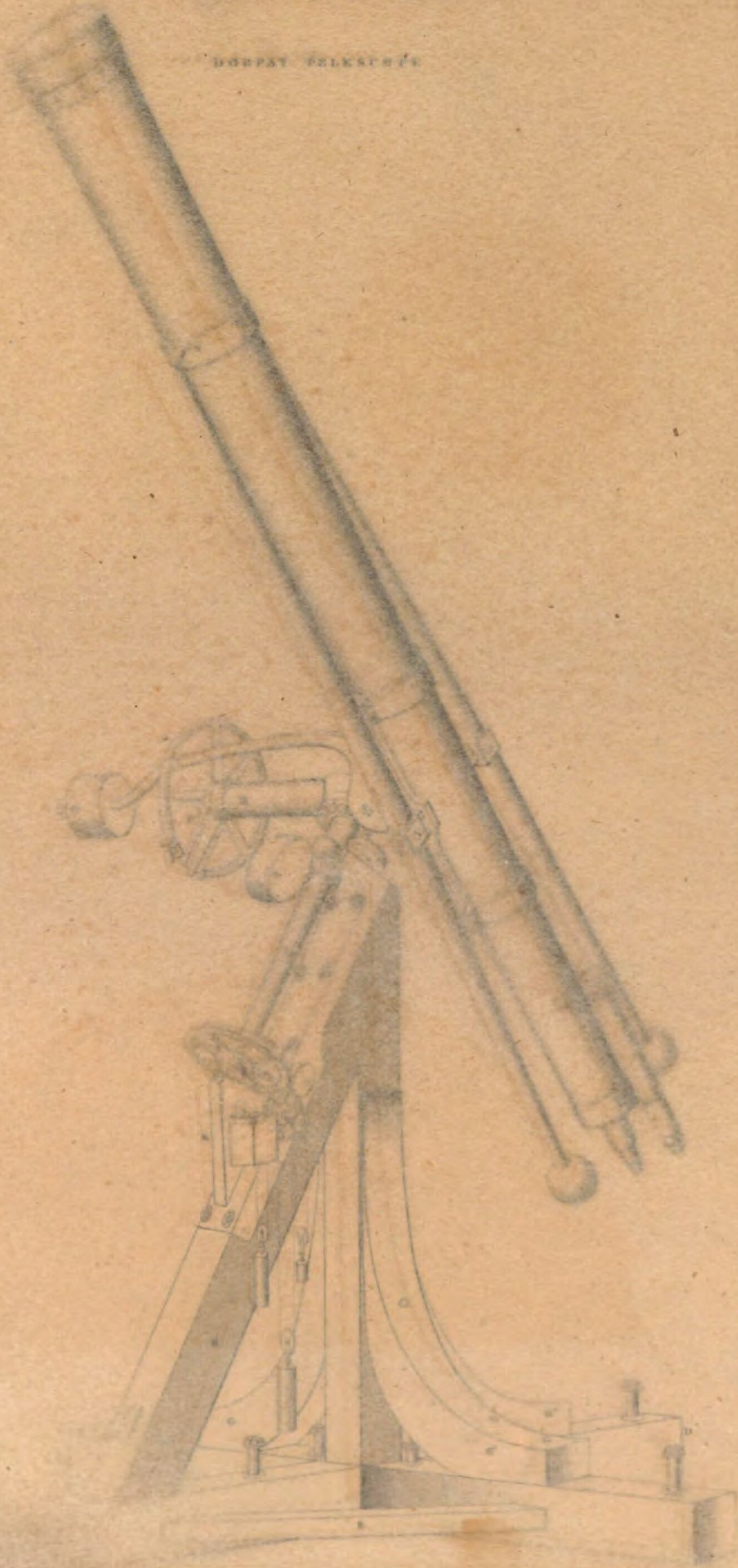
Fig. 137.



ASTRONOMY.

PLATE II.

DORRAT TELESCOPE



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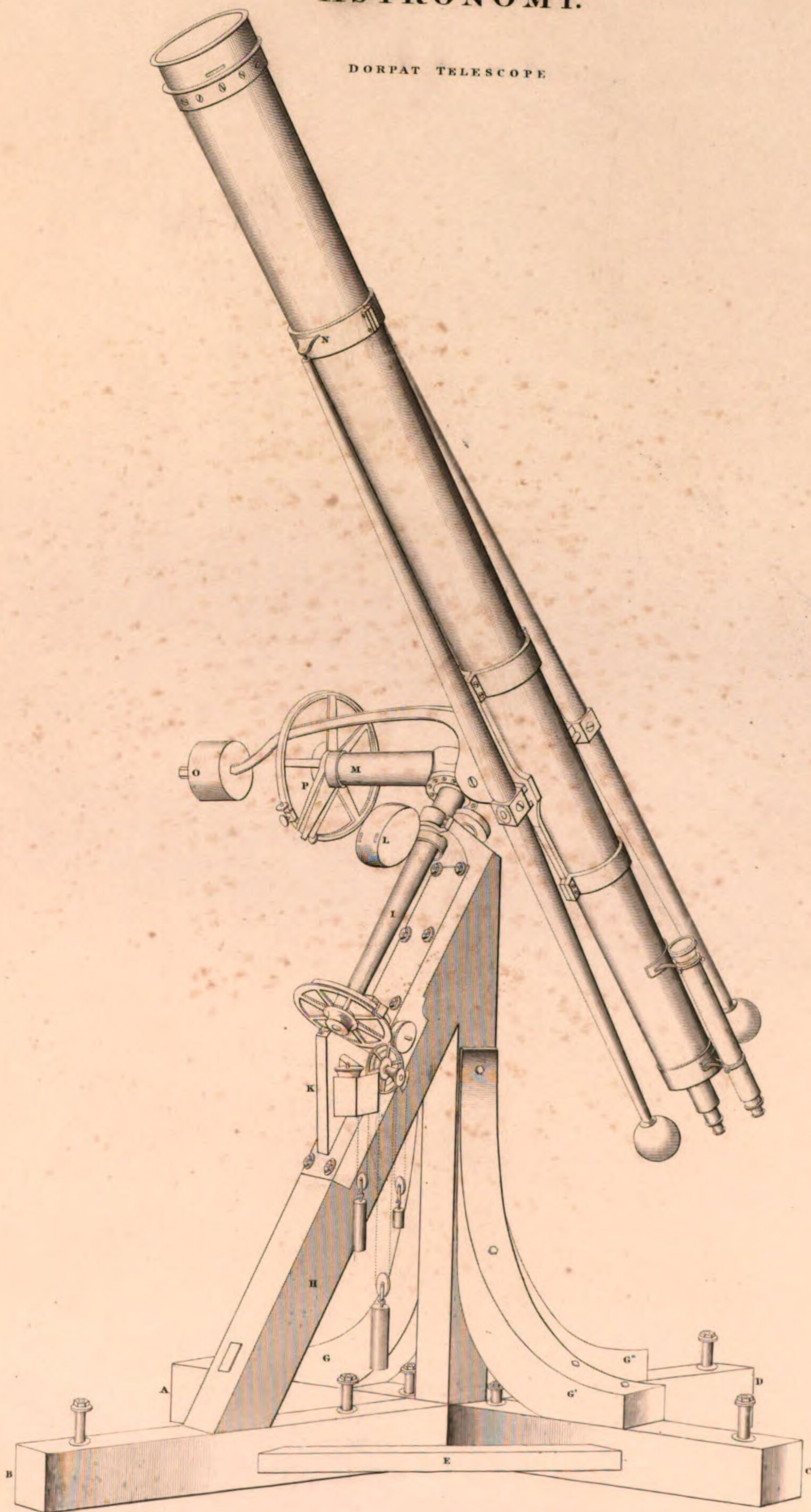
ASTOR LENOX TILDEN FOUNDATION

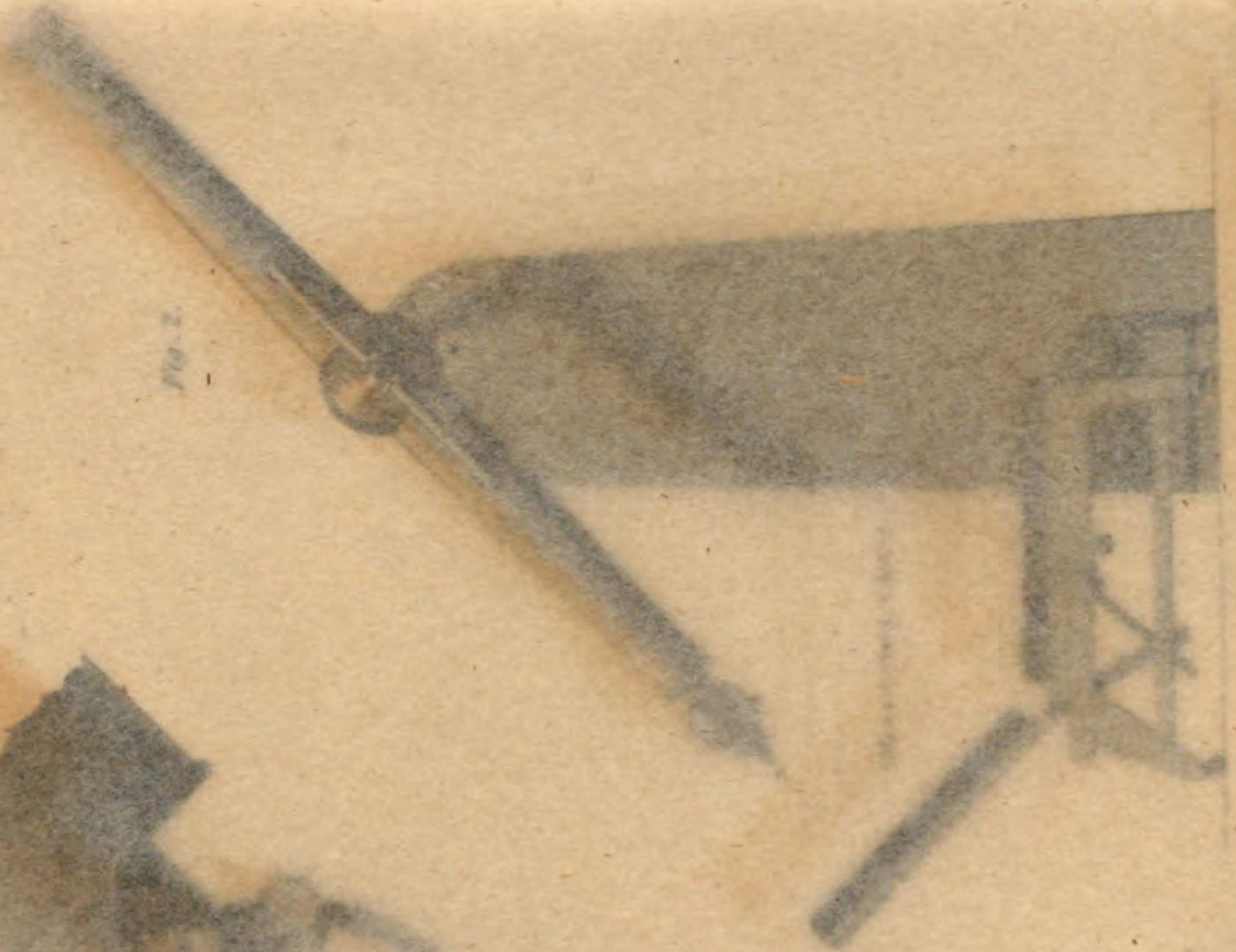
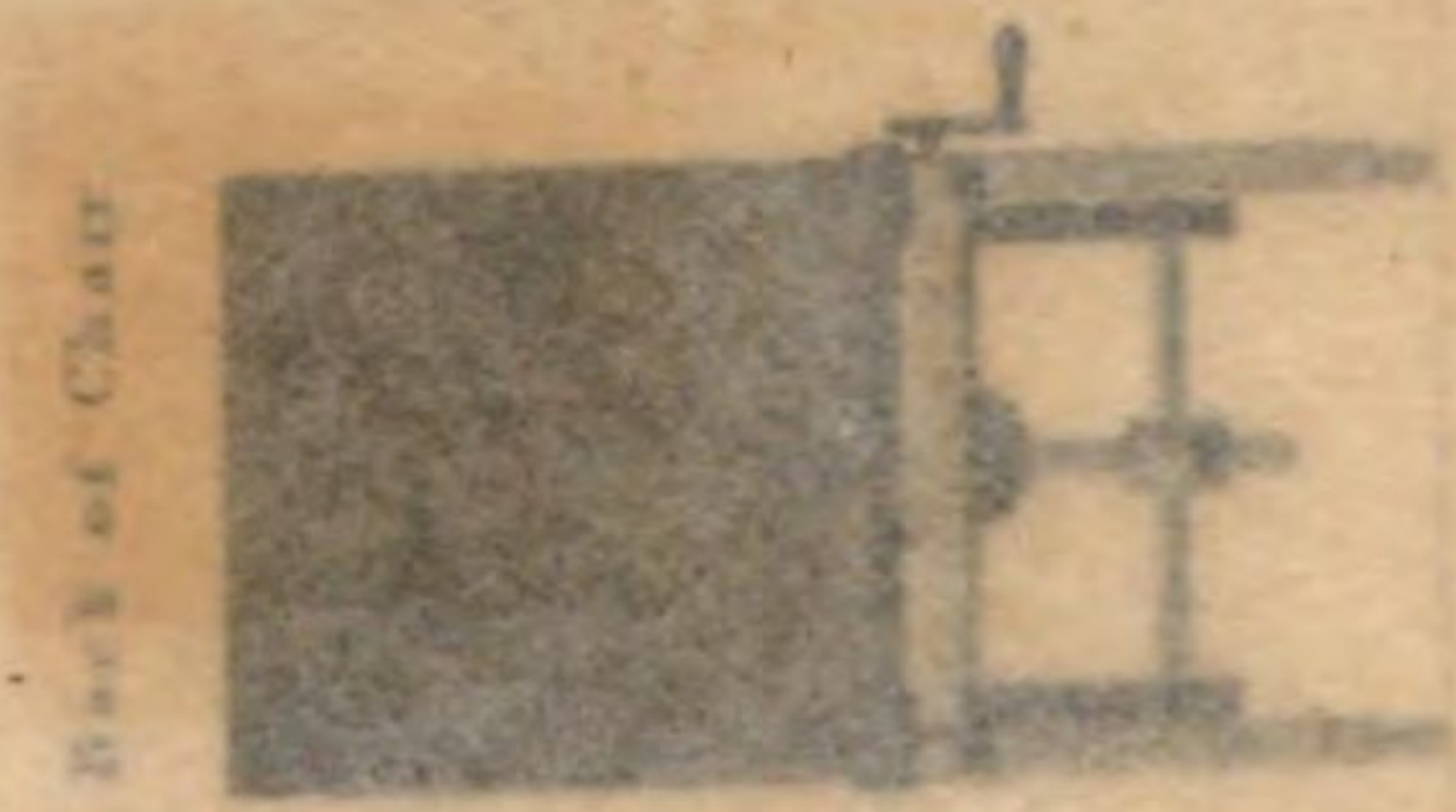
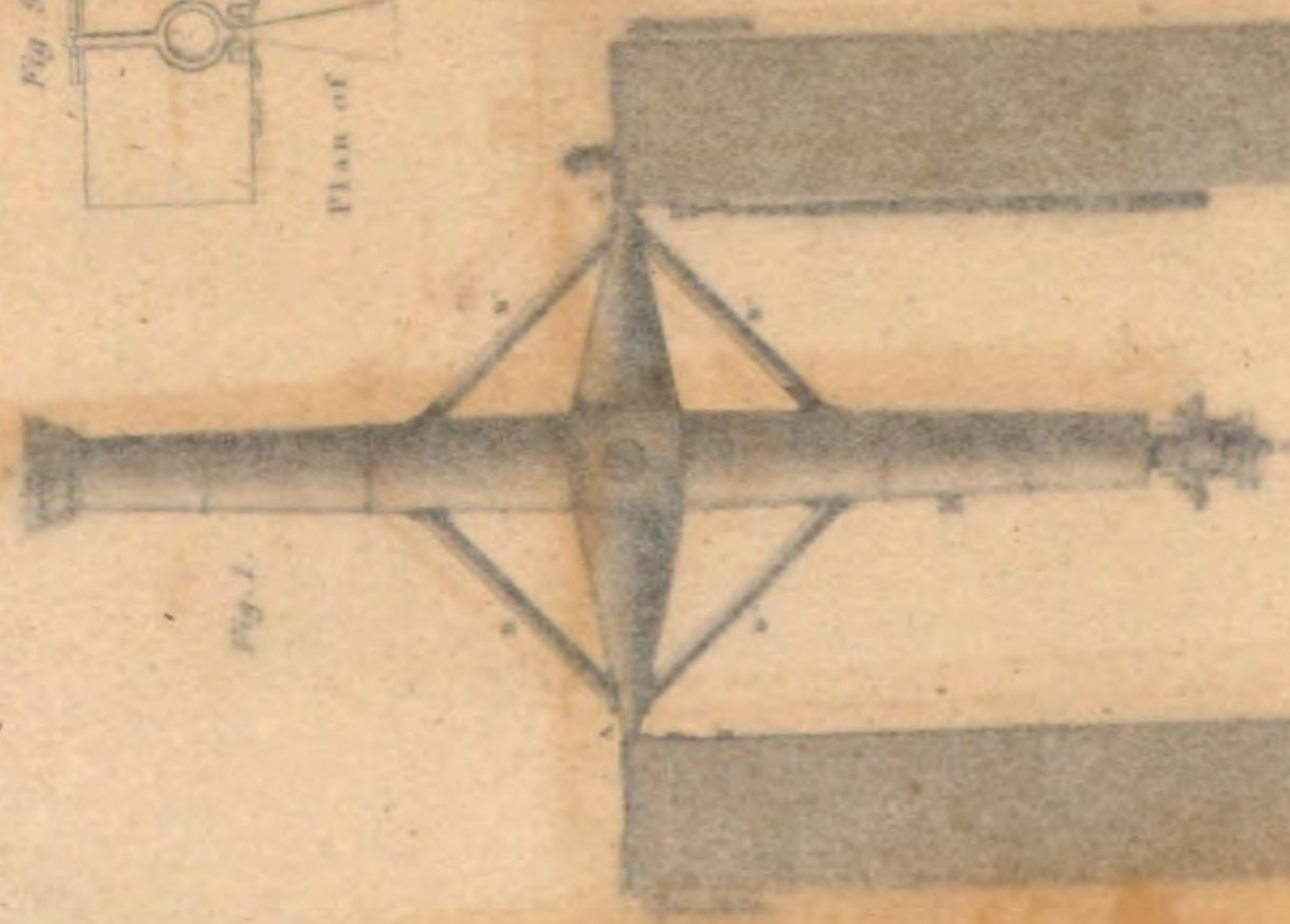
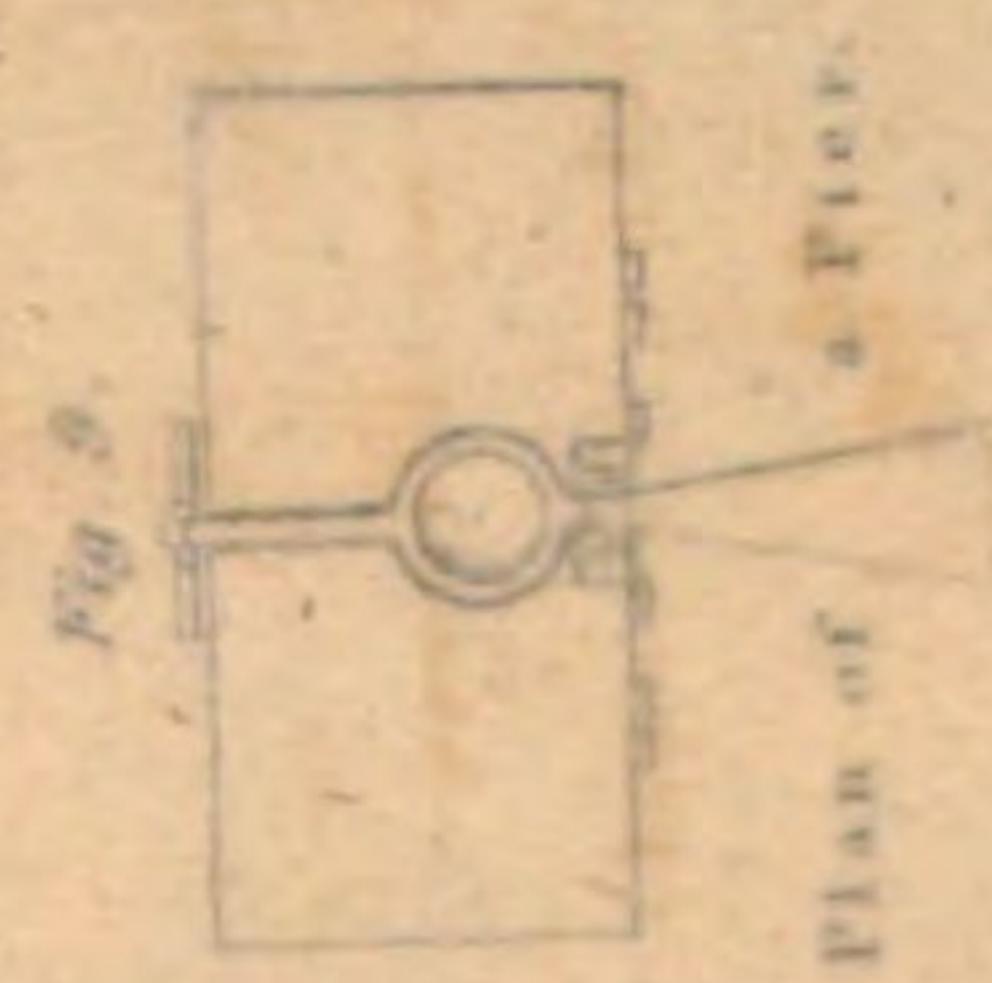


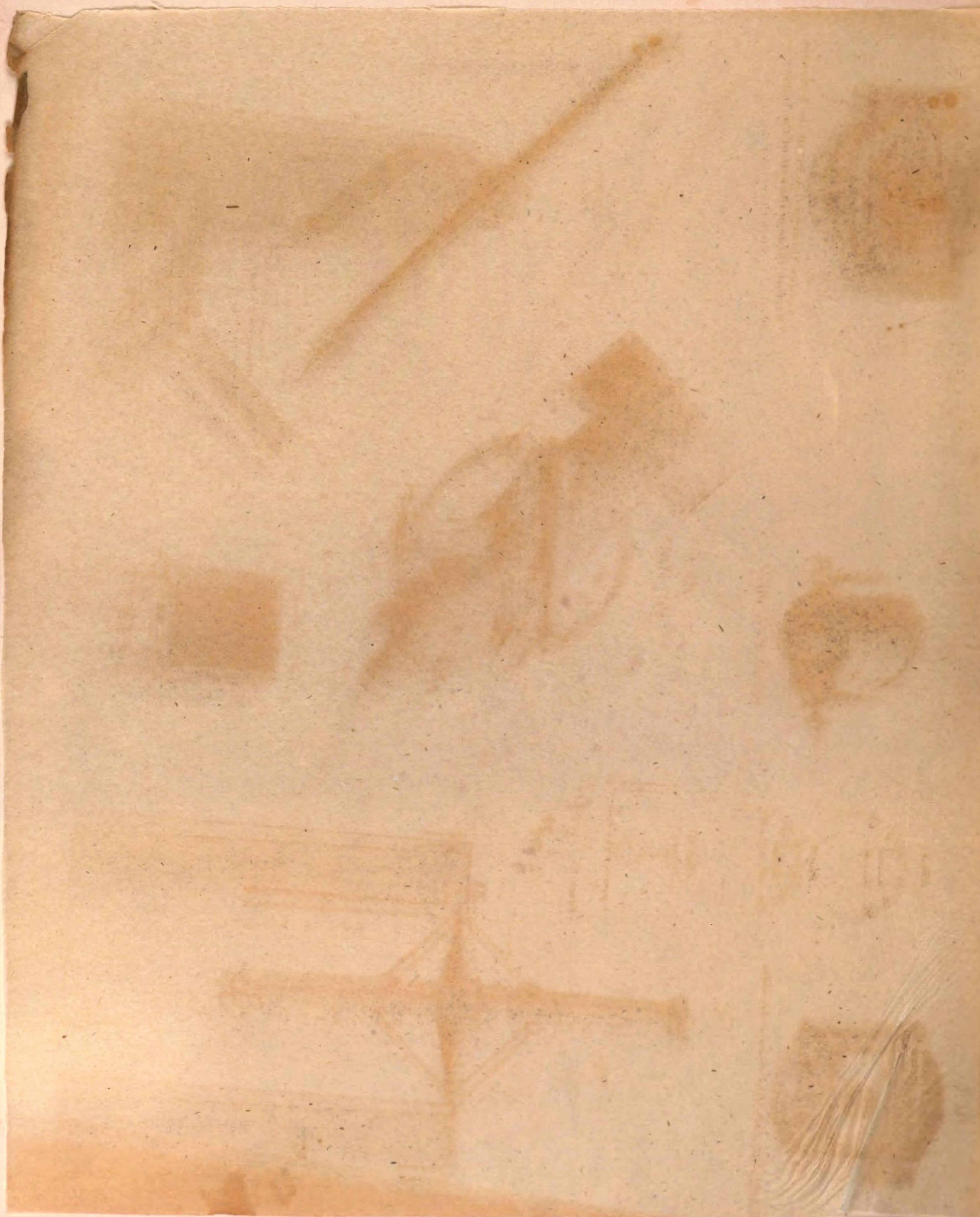
ASTRONOMY.

PLATE XCV.

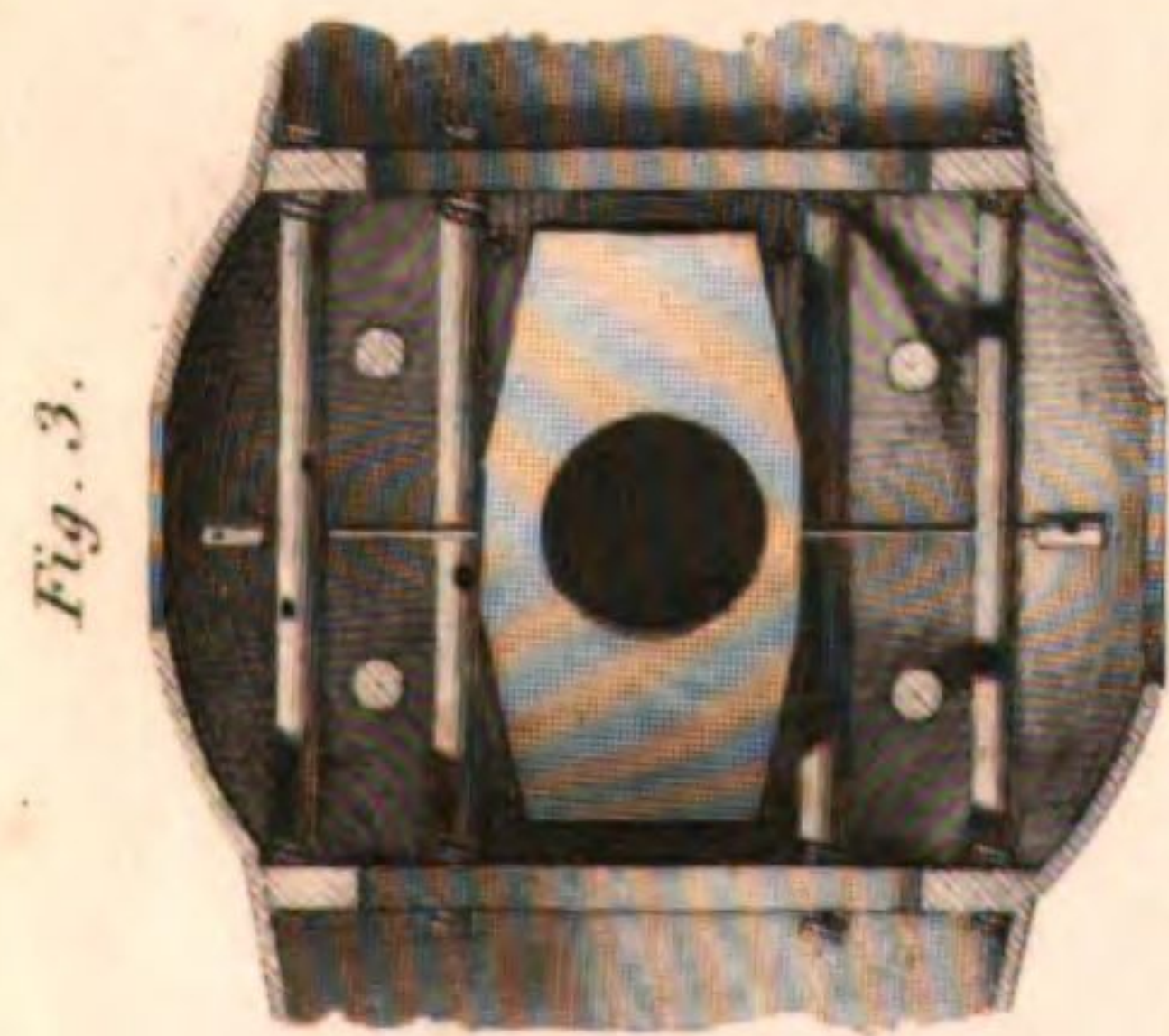
DORPAT TELESCOPE



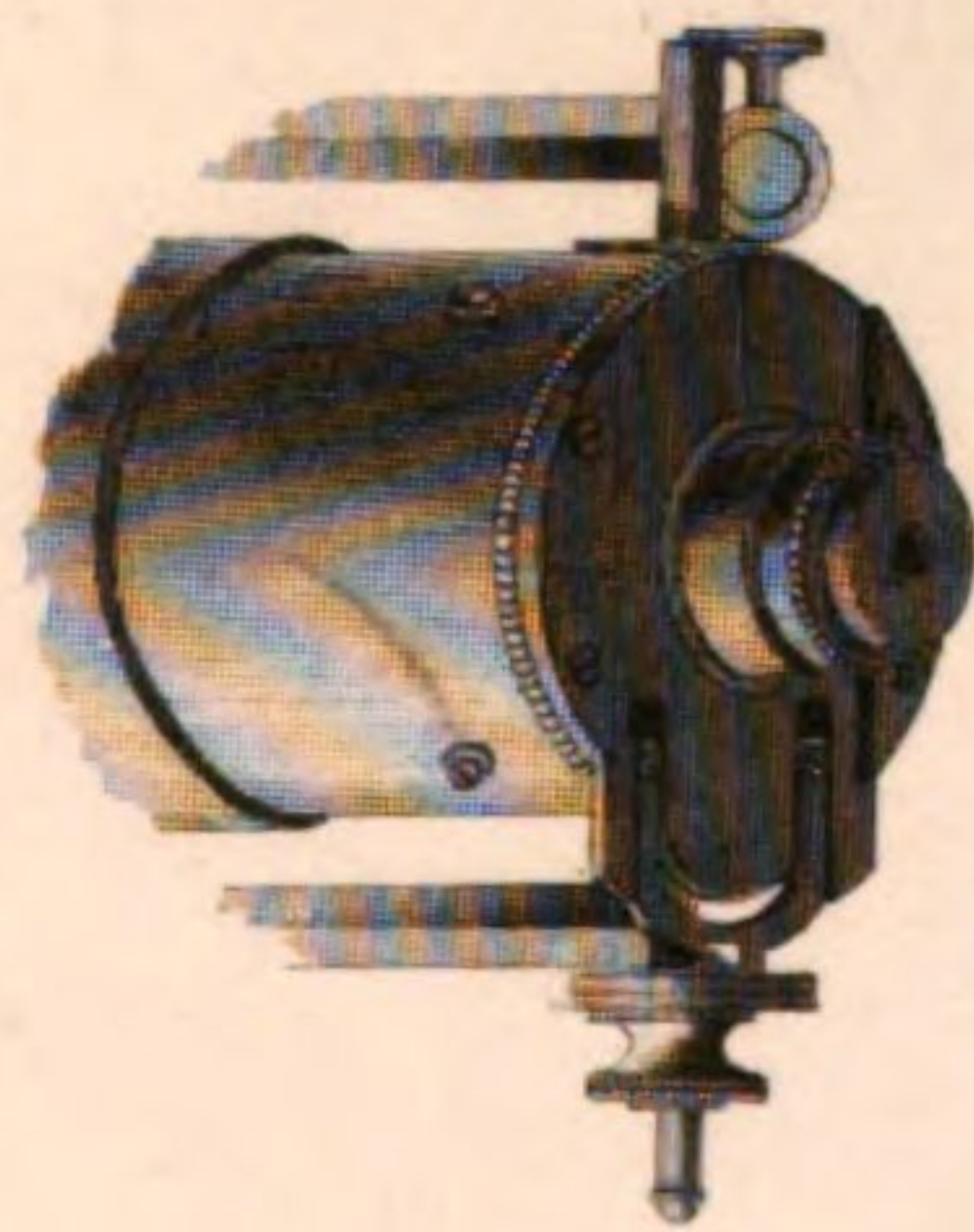
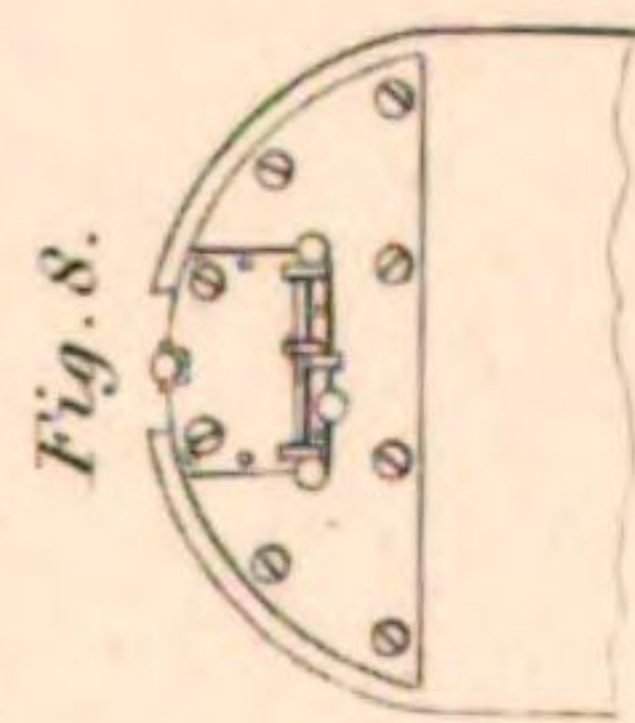
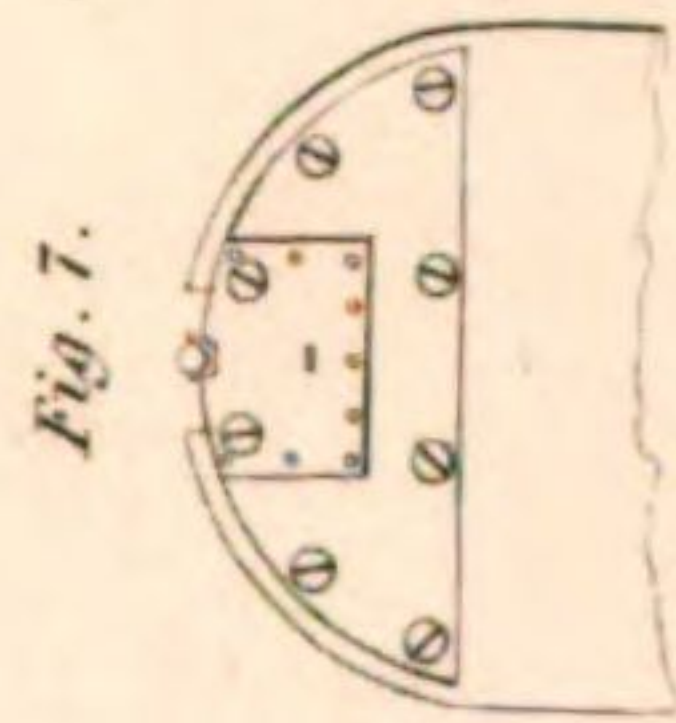




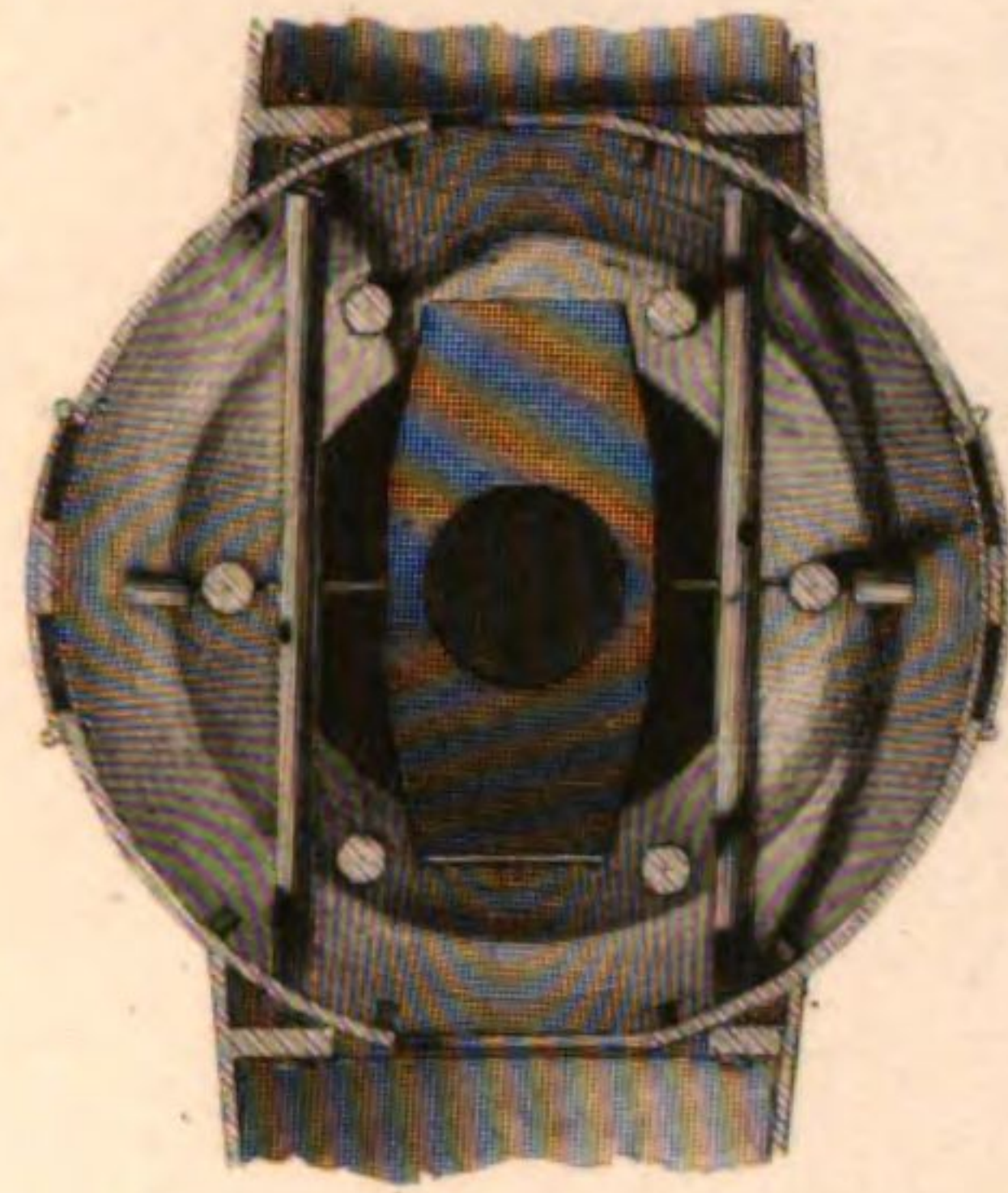
TRANSIT INSTRUMENT.



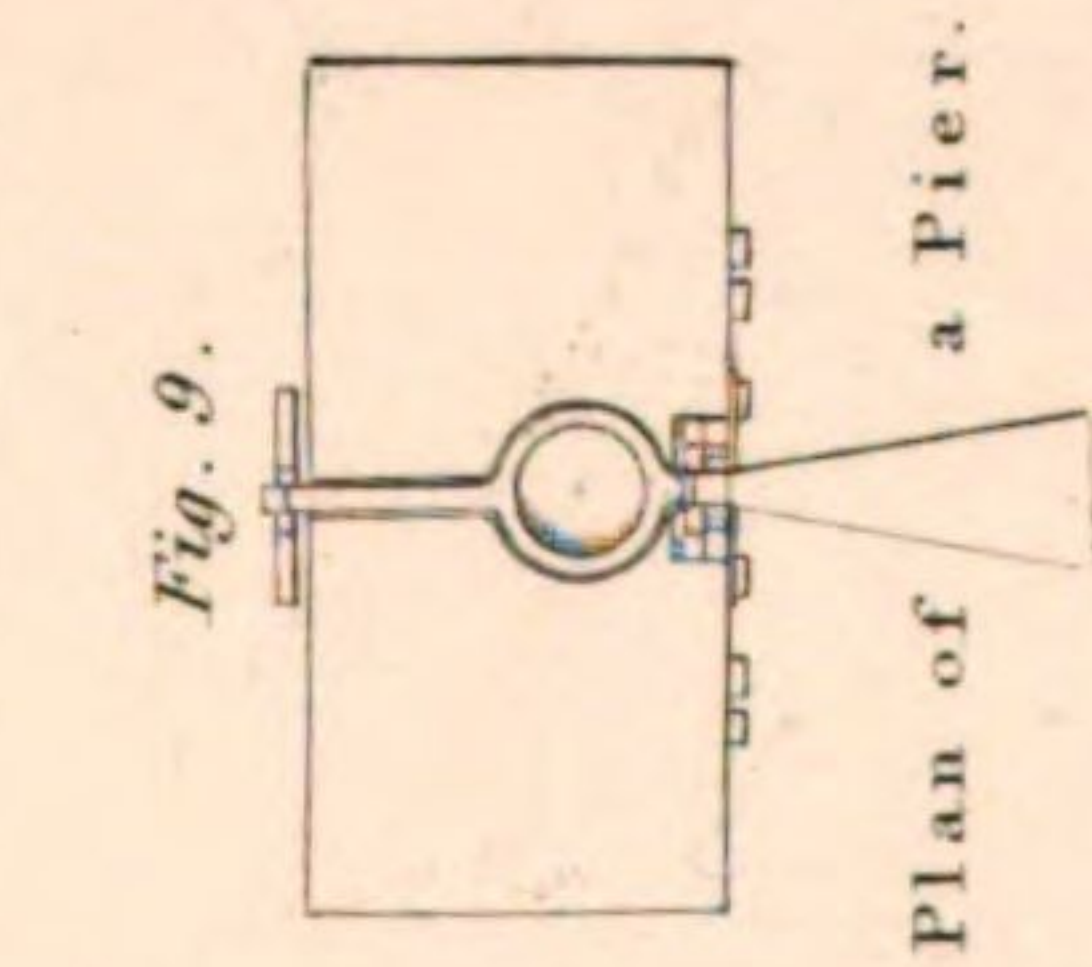
Section through the Transverse axis.



Front of eye piece.



Section through the axis of the Telescope.



Plan of a Pier.

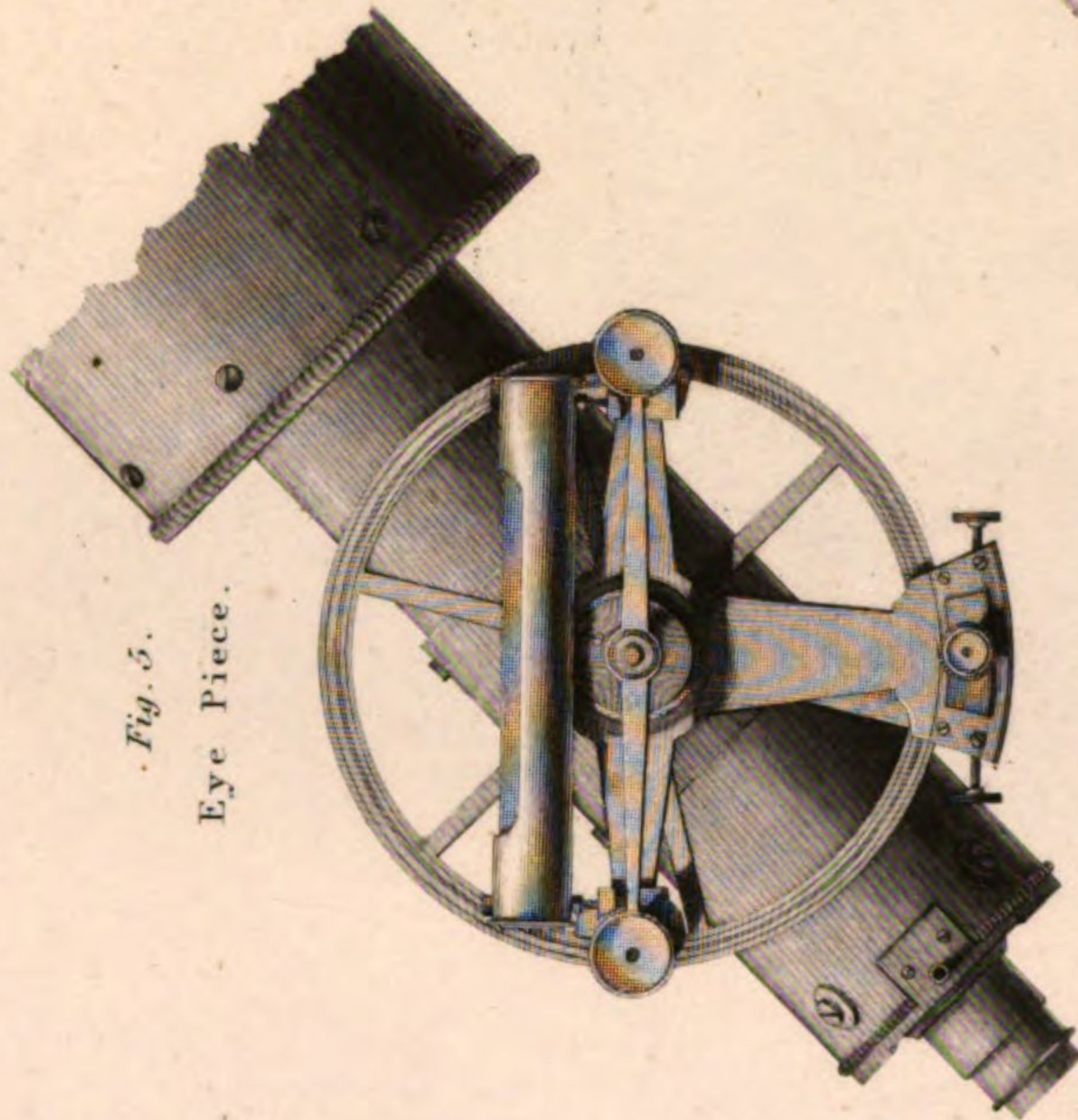


Fig. 5.
Eye Piece.

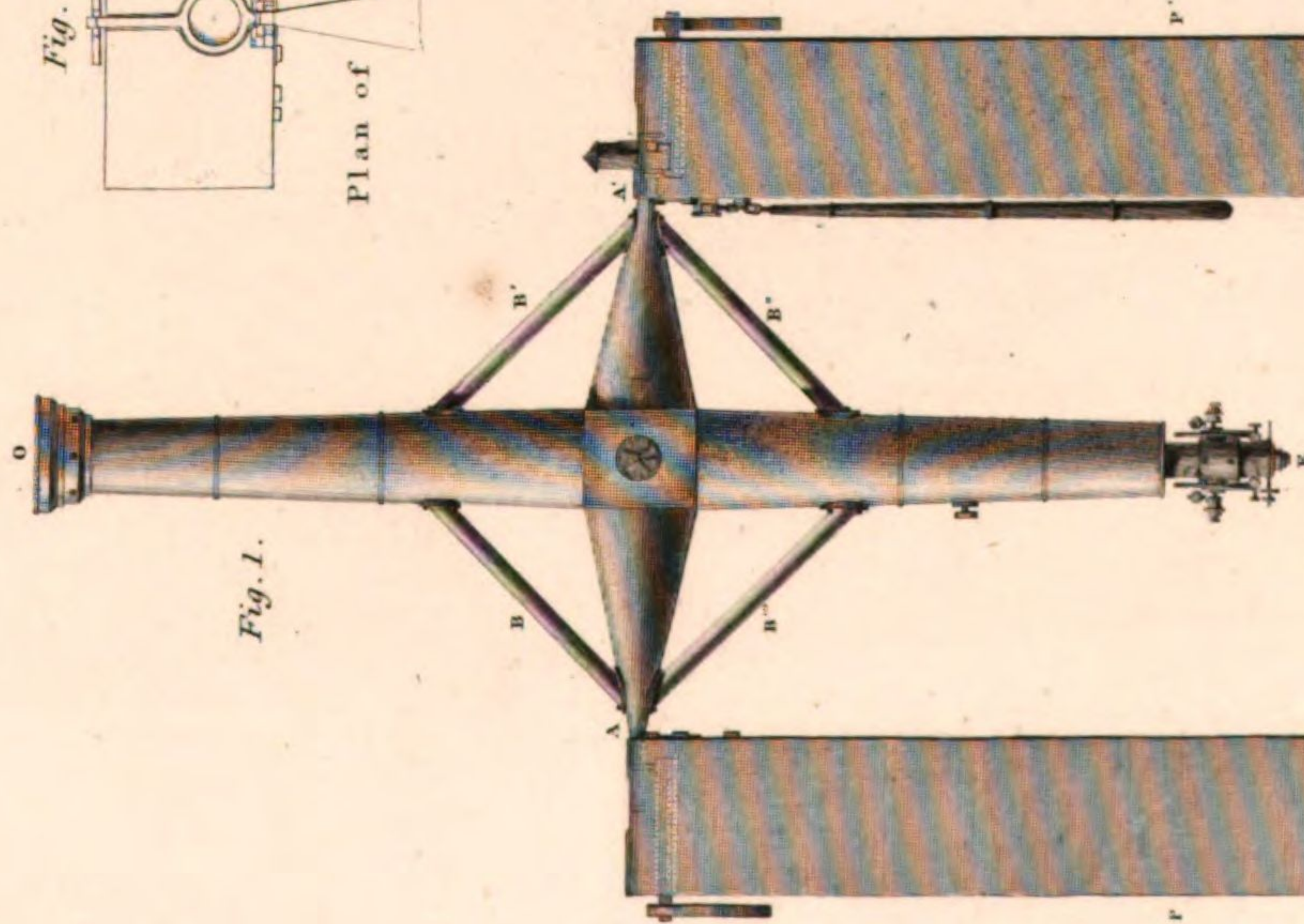


Fig. 1.

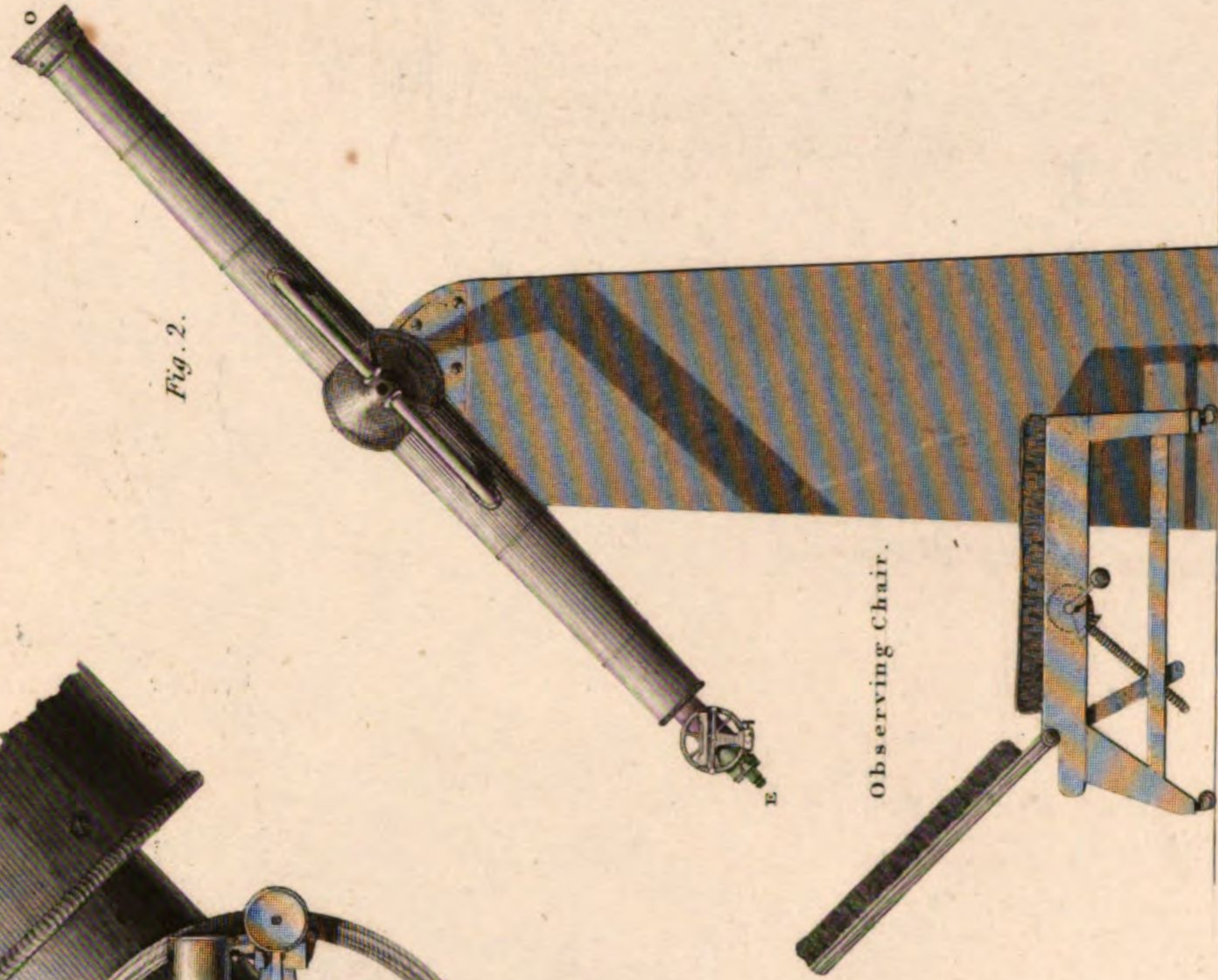
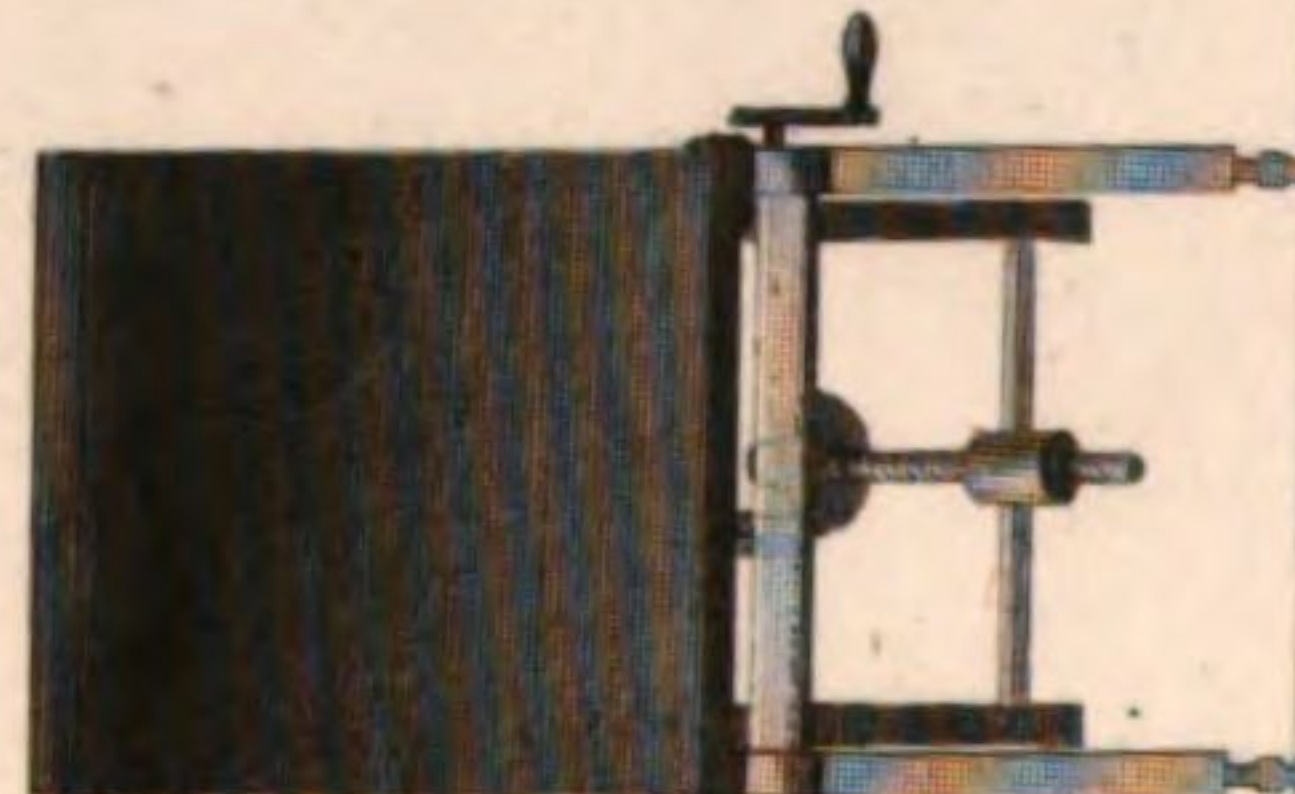
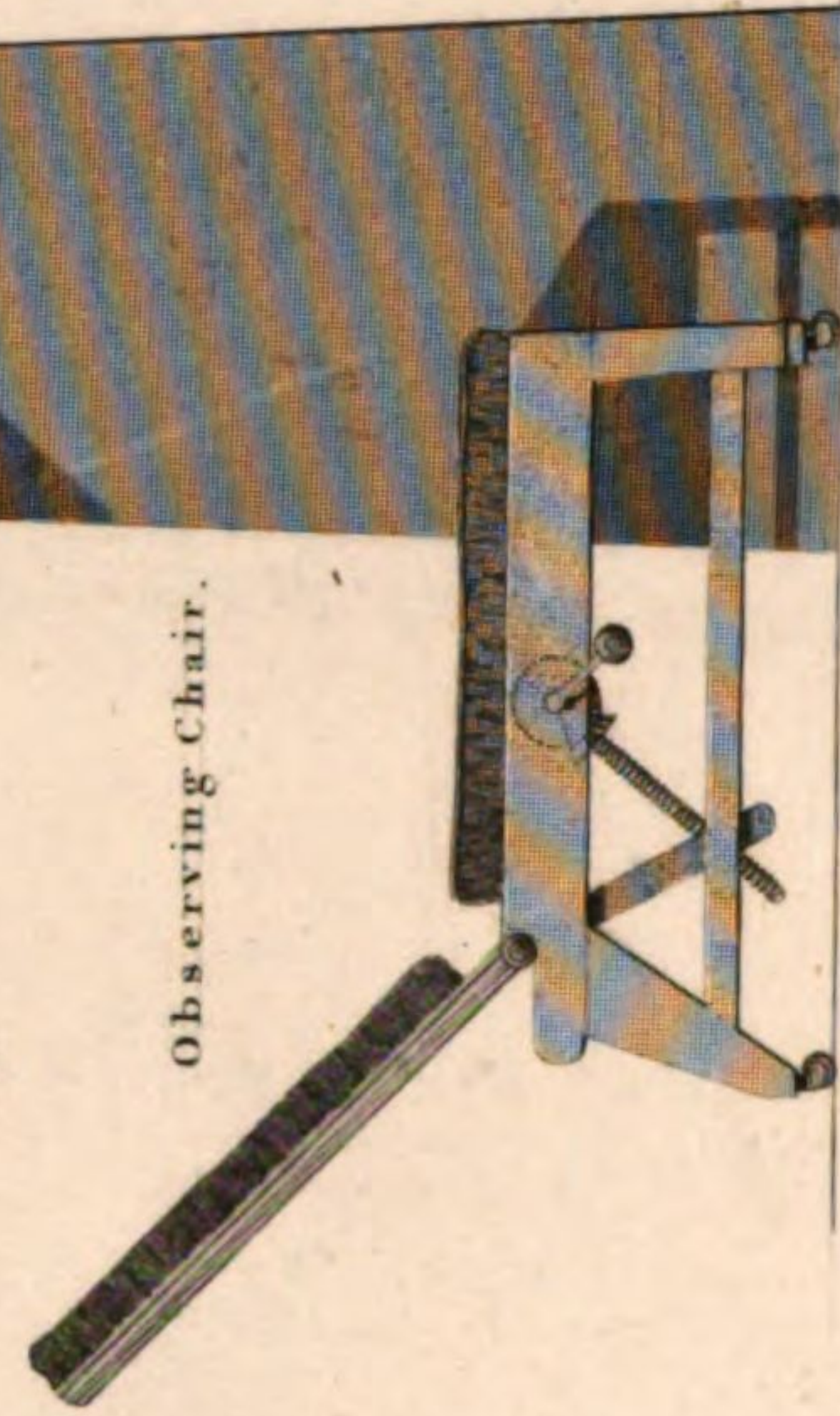


Fig. 2.

Back of Chair.



Observing Chair.



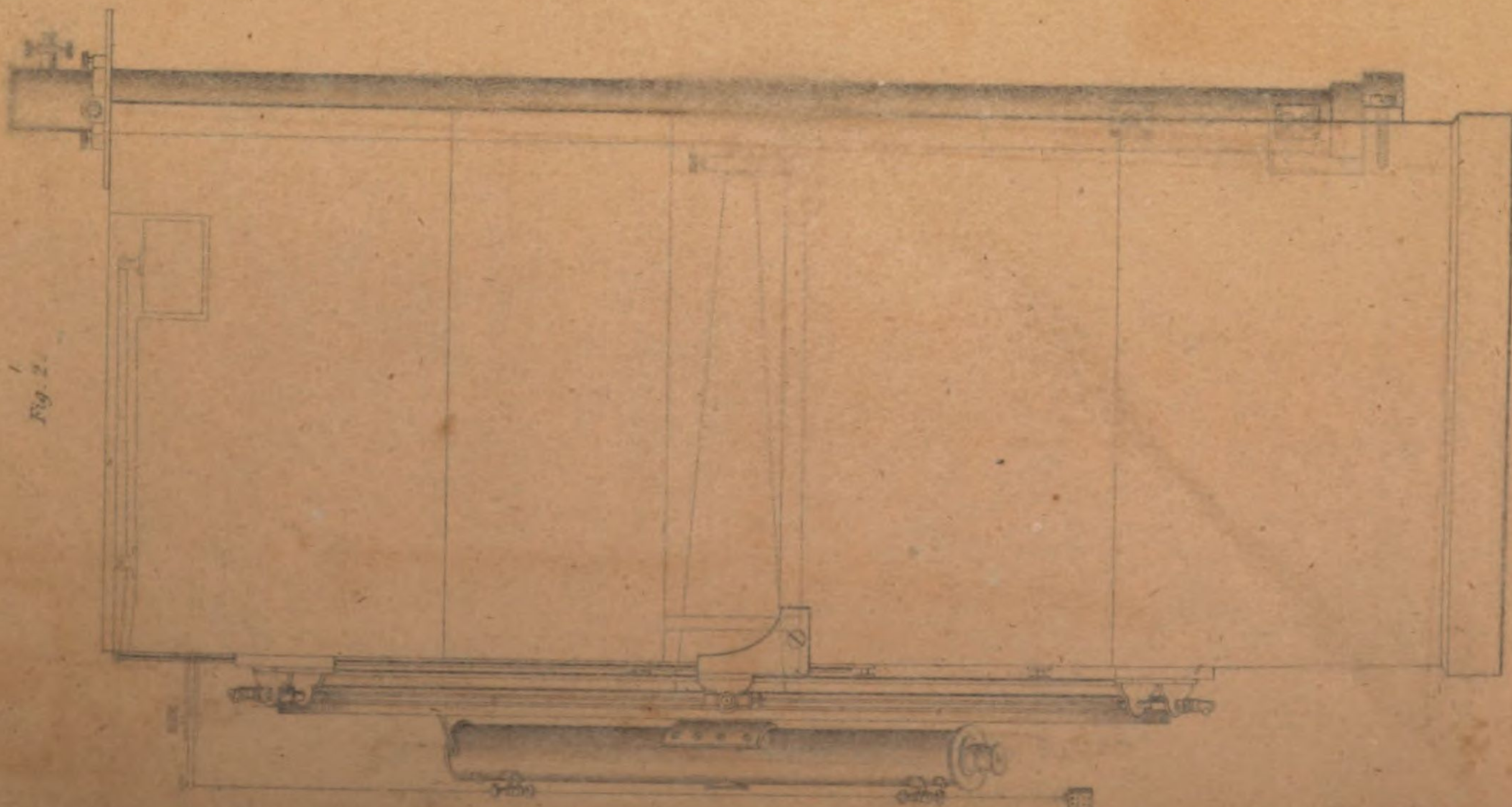
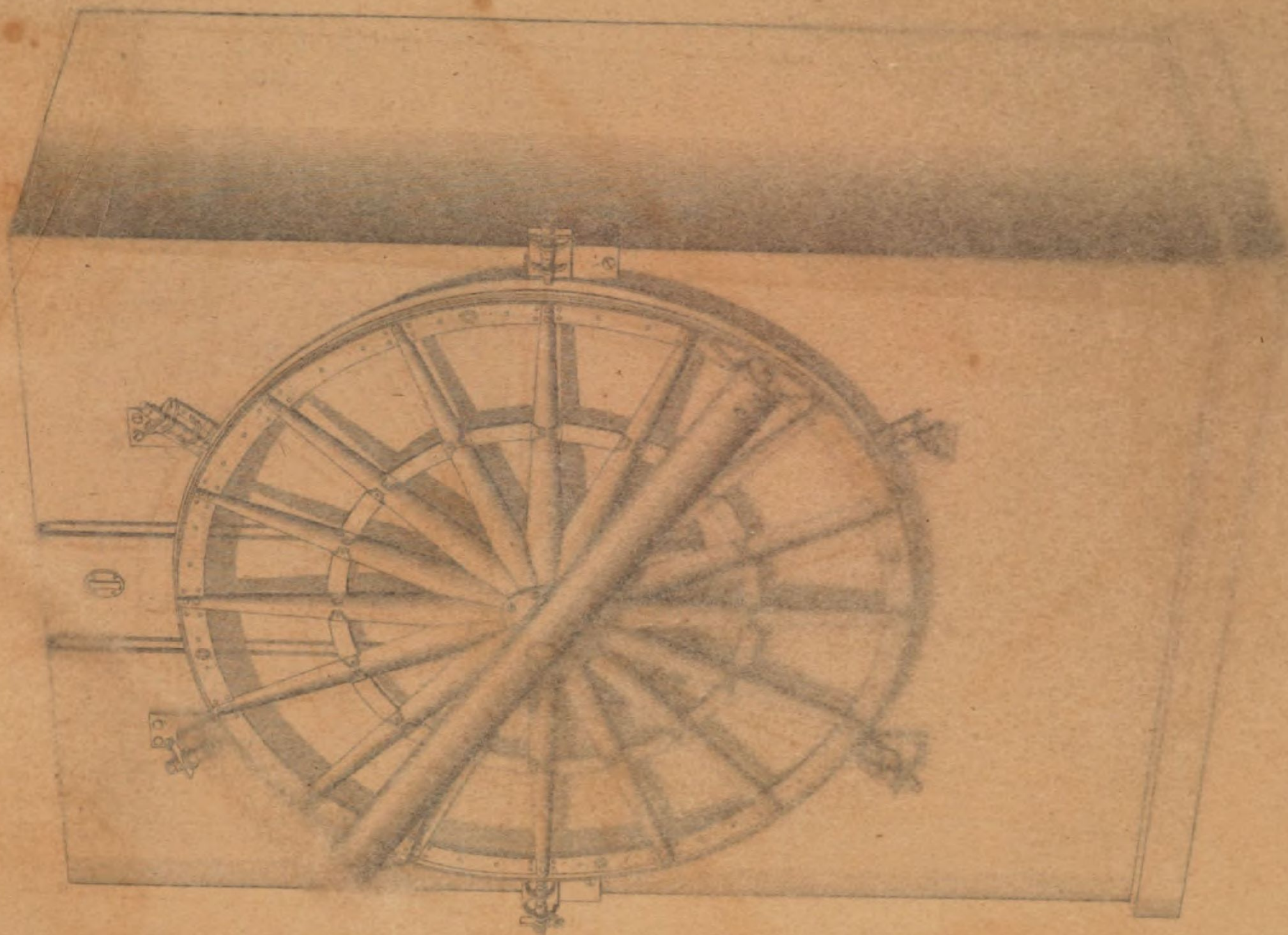


Fig. 2.



MURAL CIRCLE.

Fig. 1.

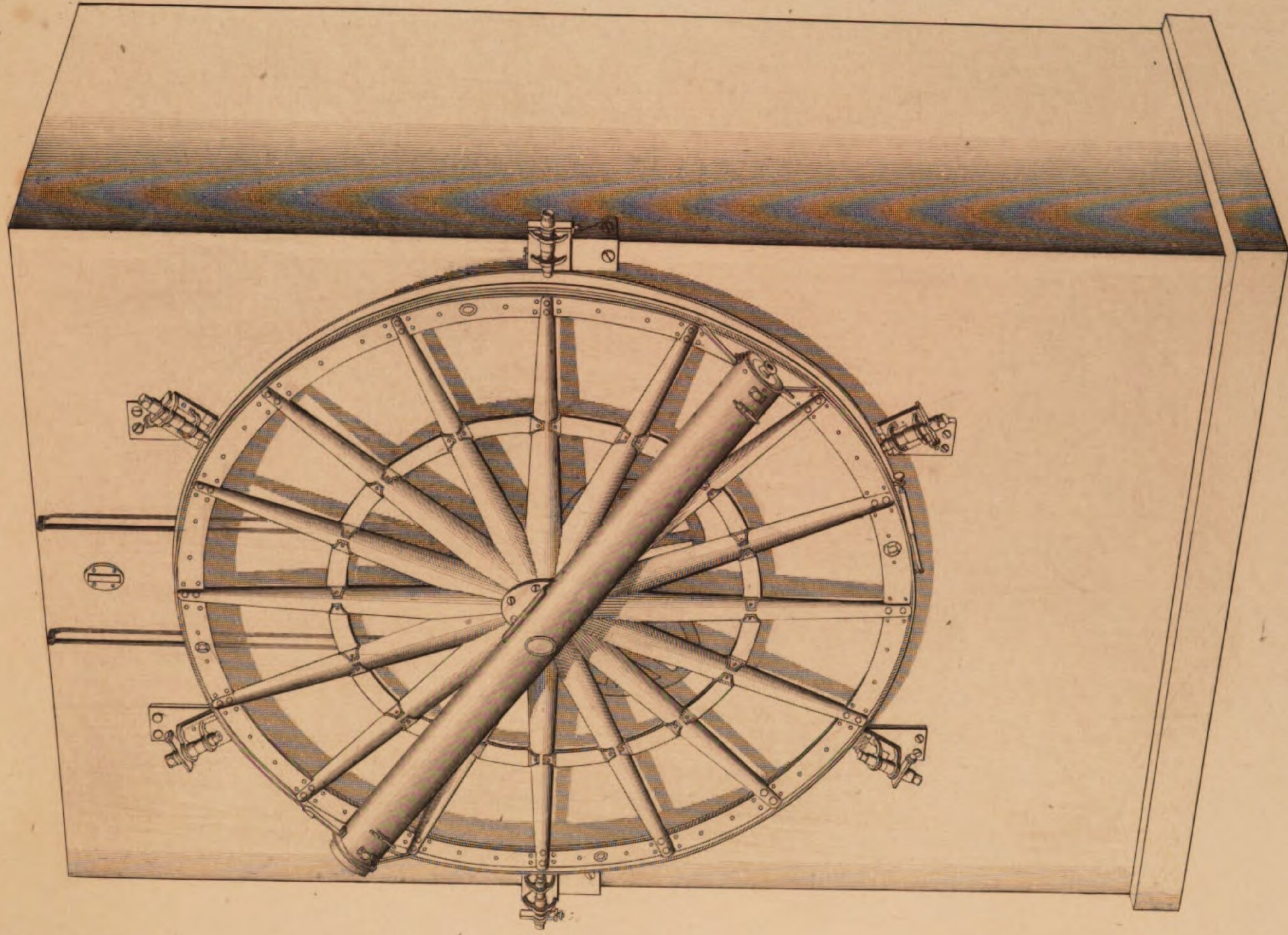
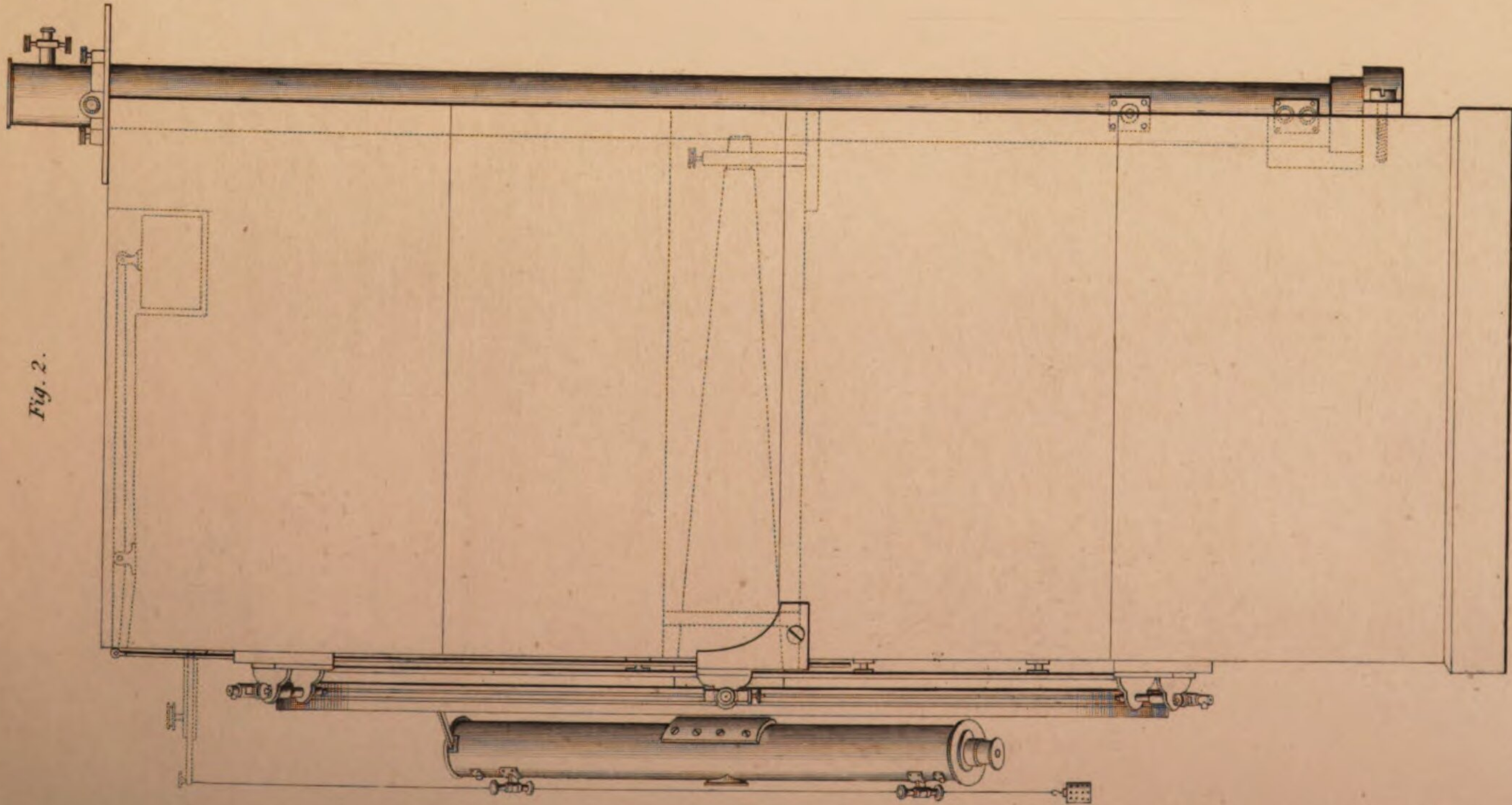


Fig. 2.



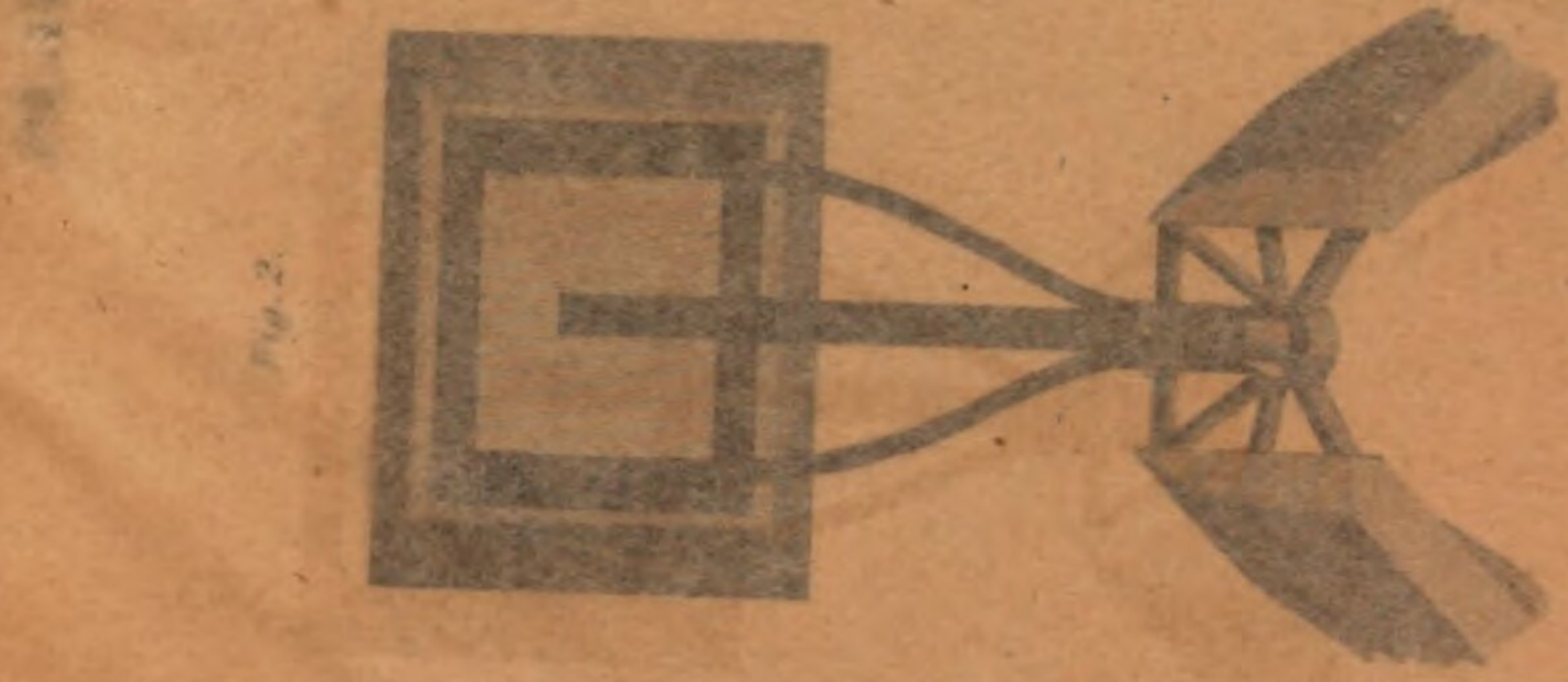


Fig. 2.



Fig. 3.

FIVE FEET COUPLER



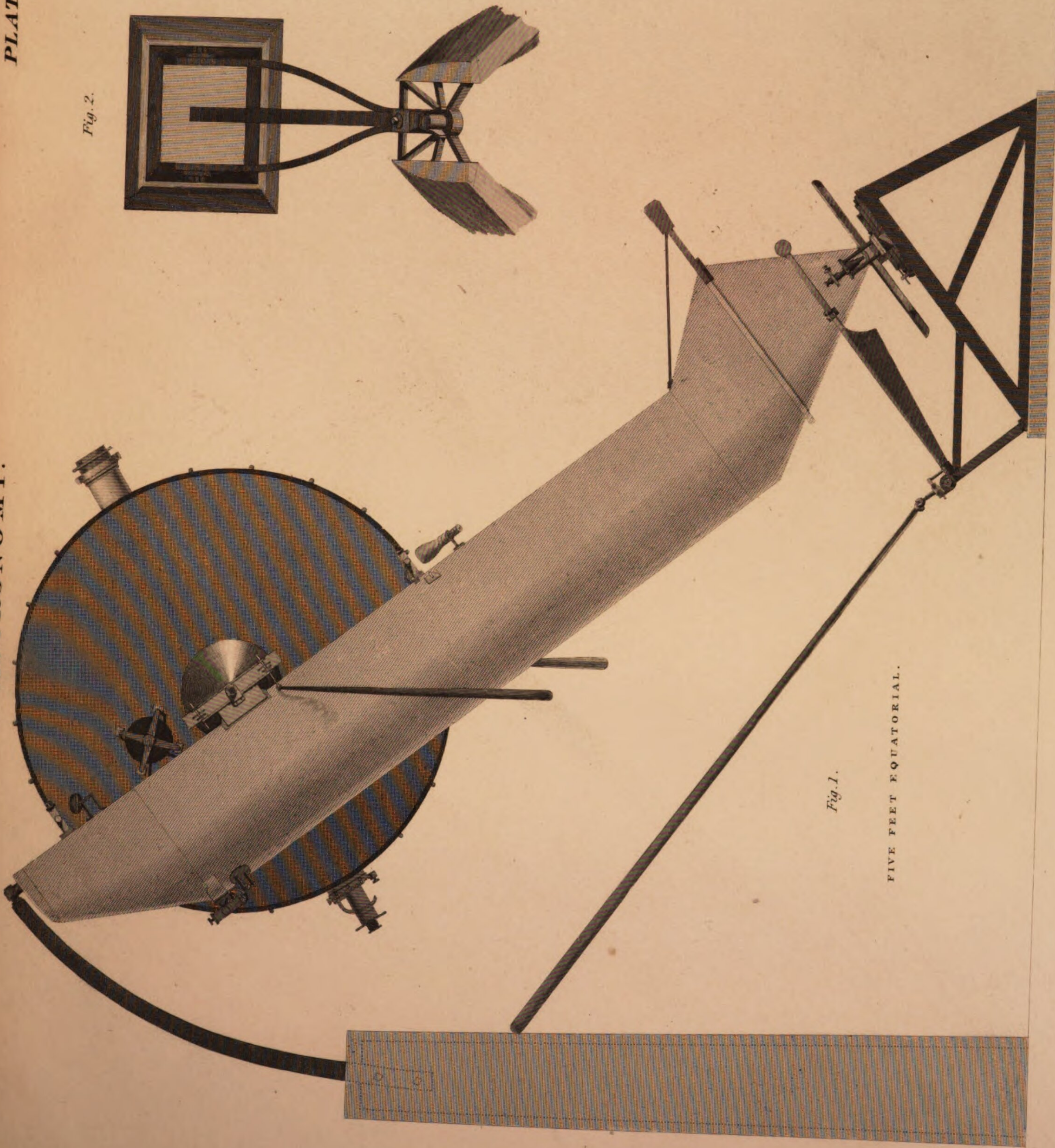
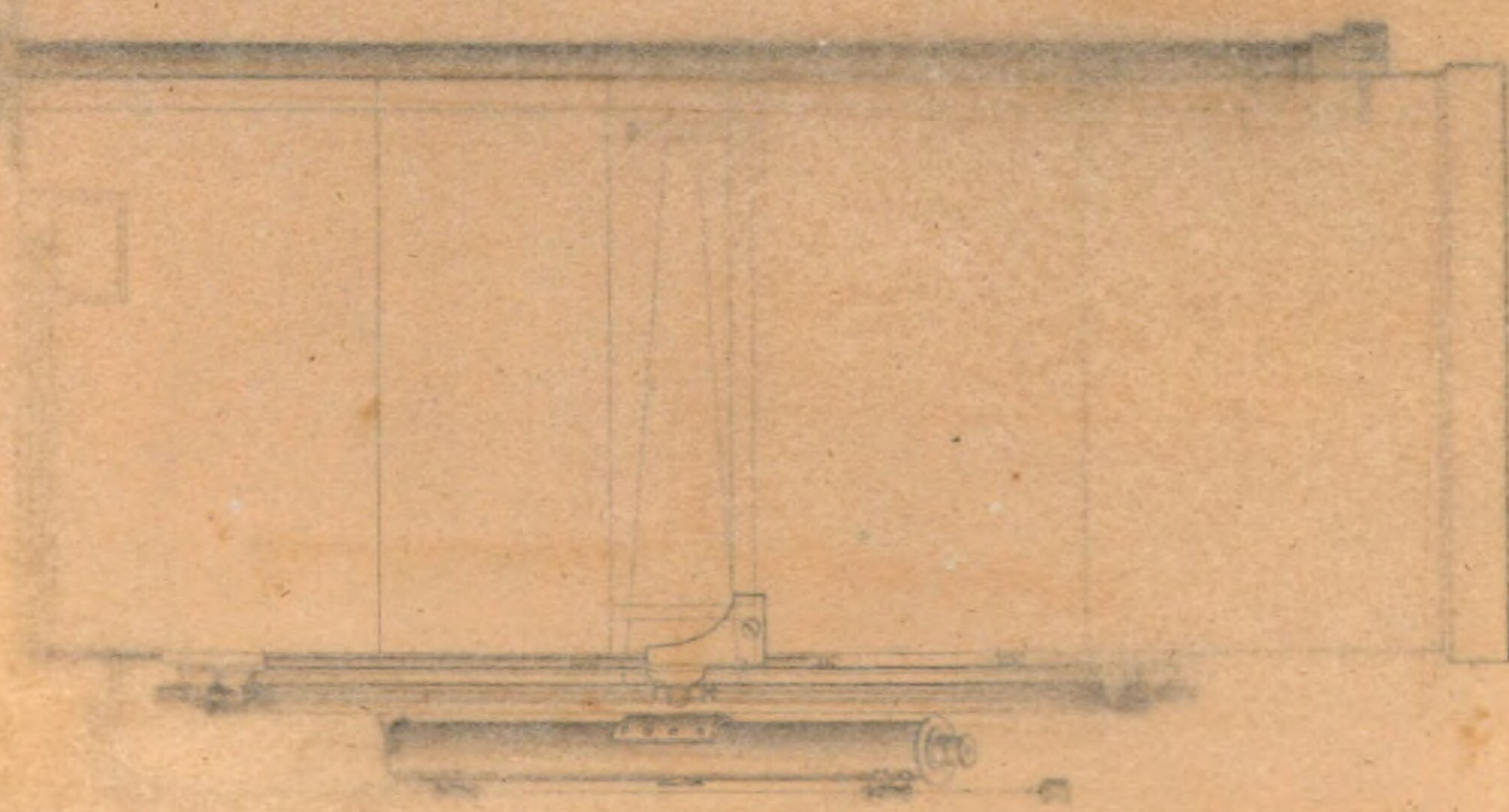
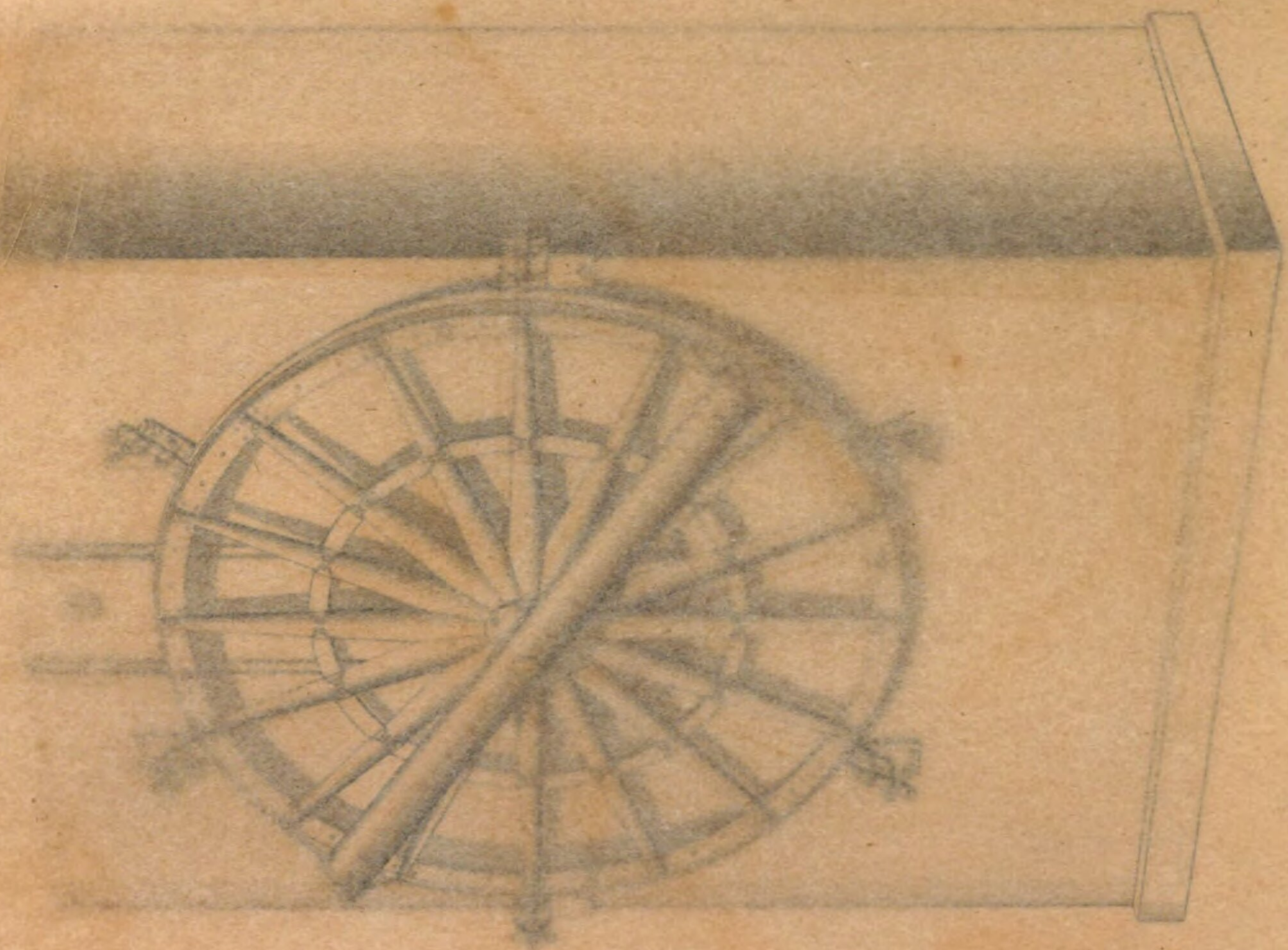


Fig. 1.

FIVE FEET EQUATORIAL.

Fig. 2.





MURAL CIRCLE.

Fig. 1.

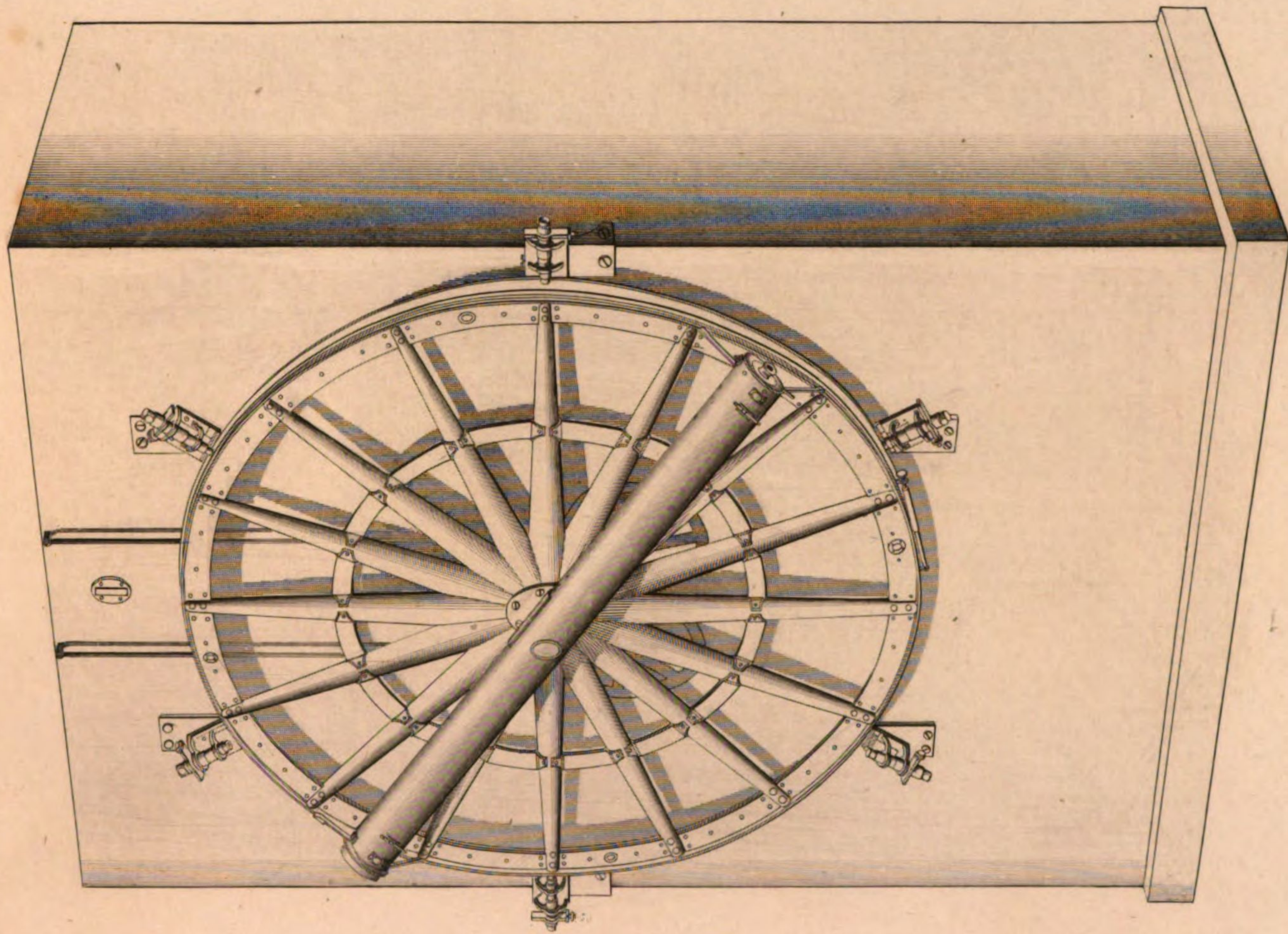
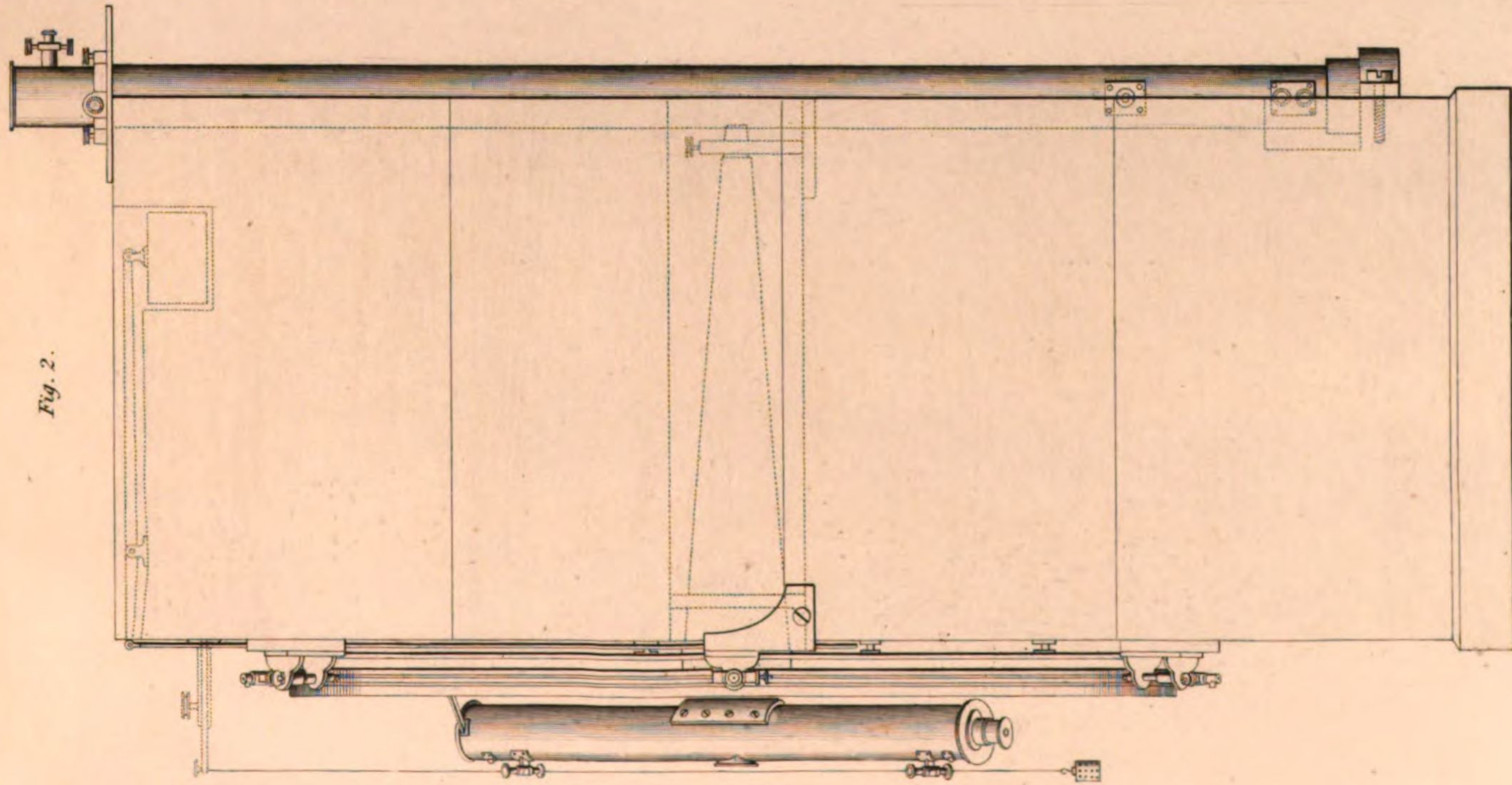
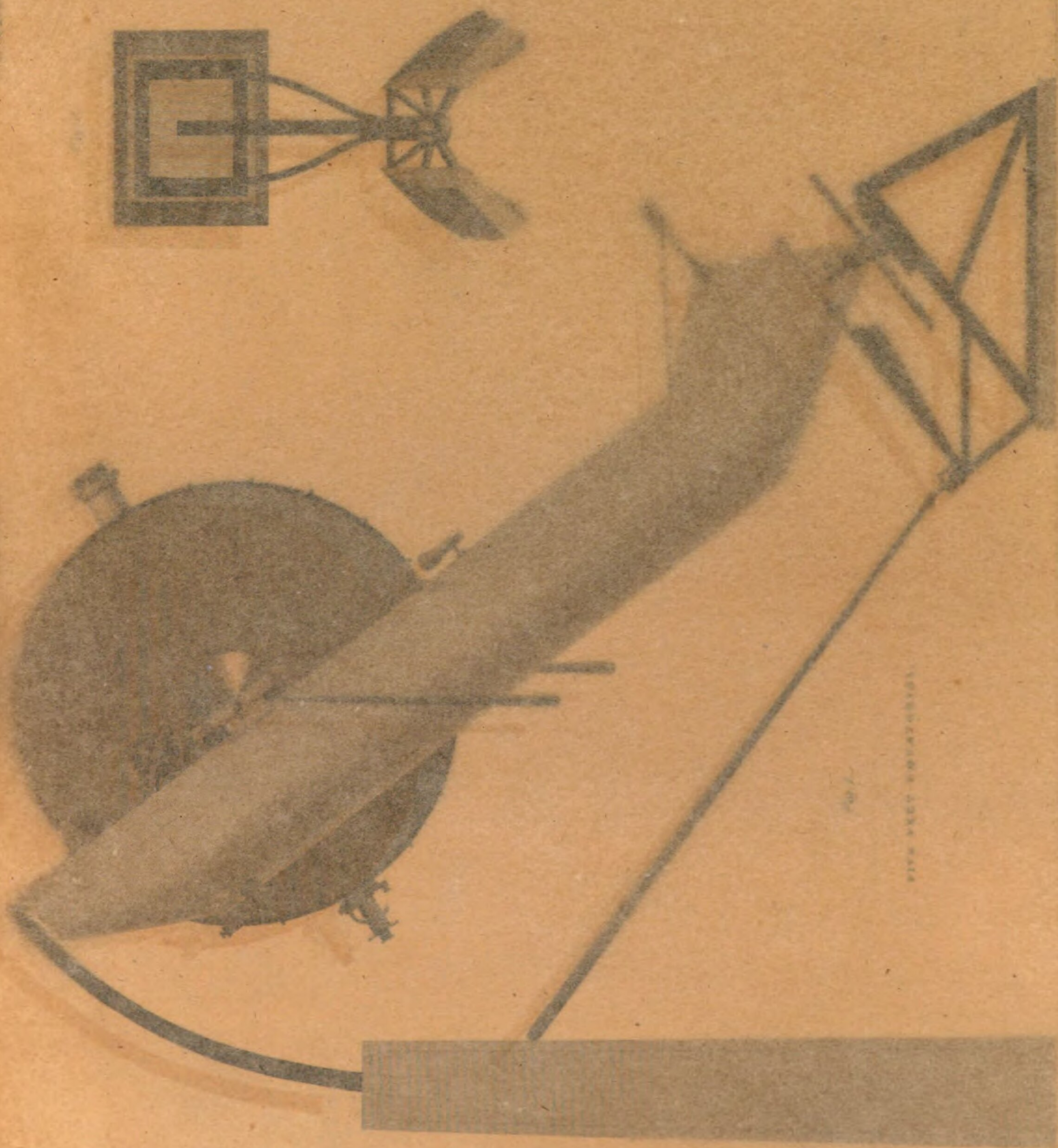
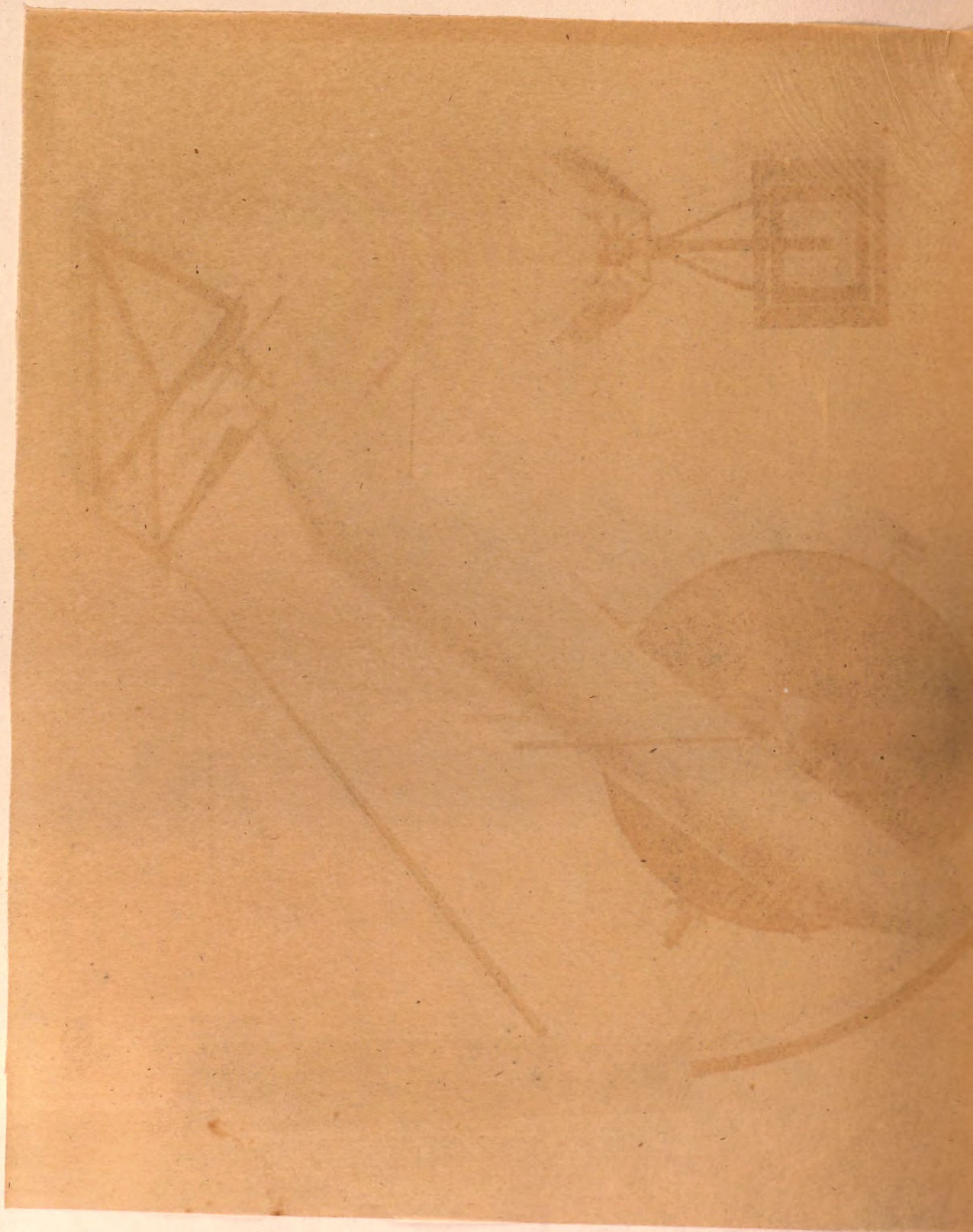


Fig. 2.







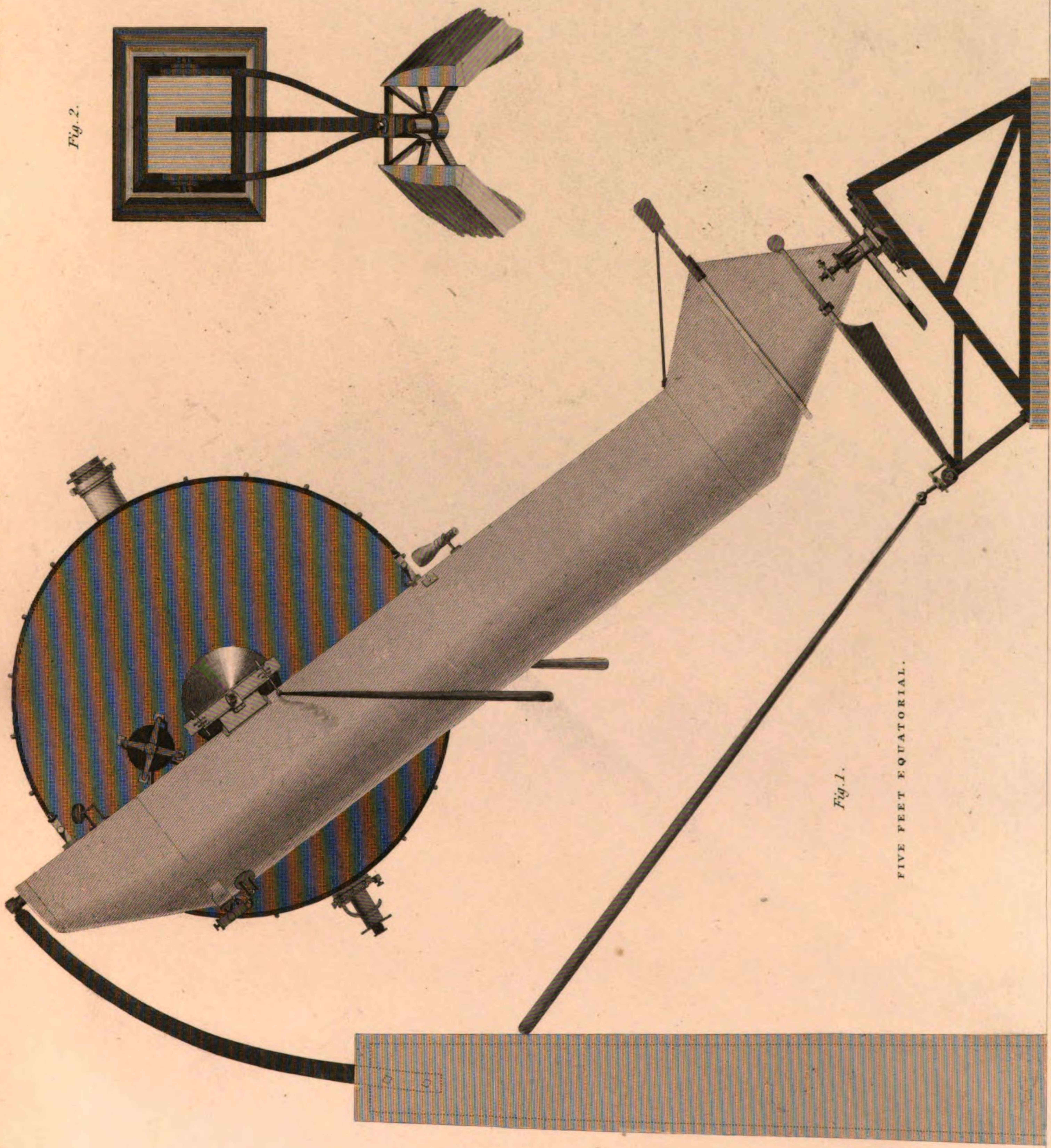
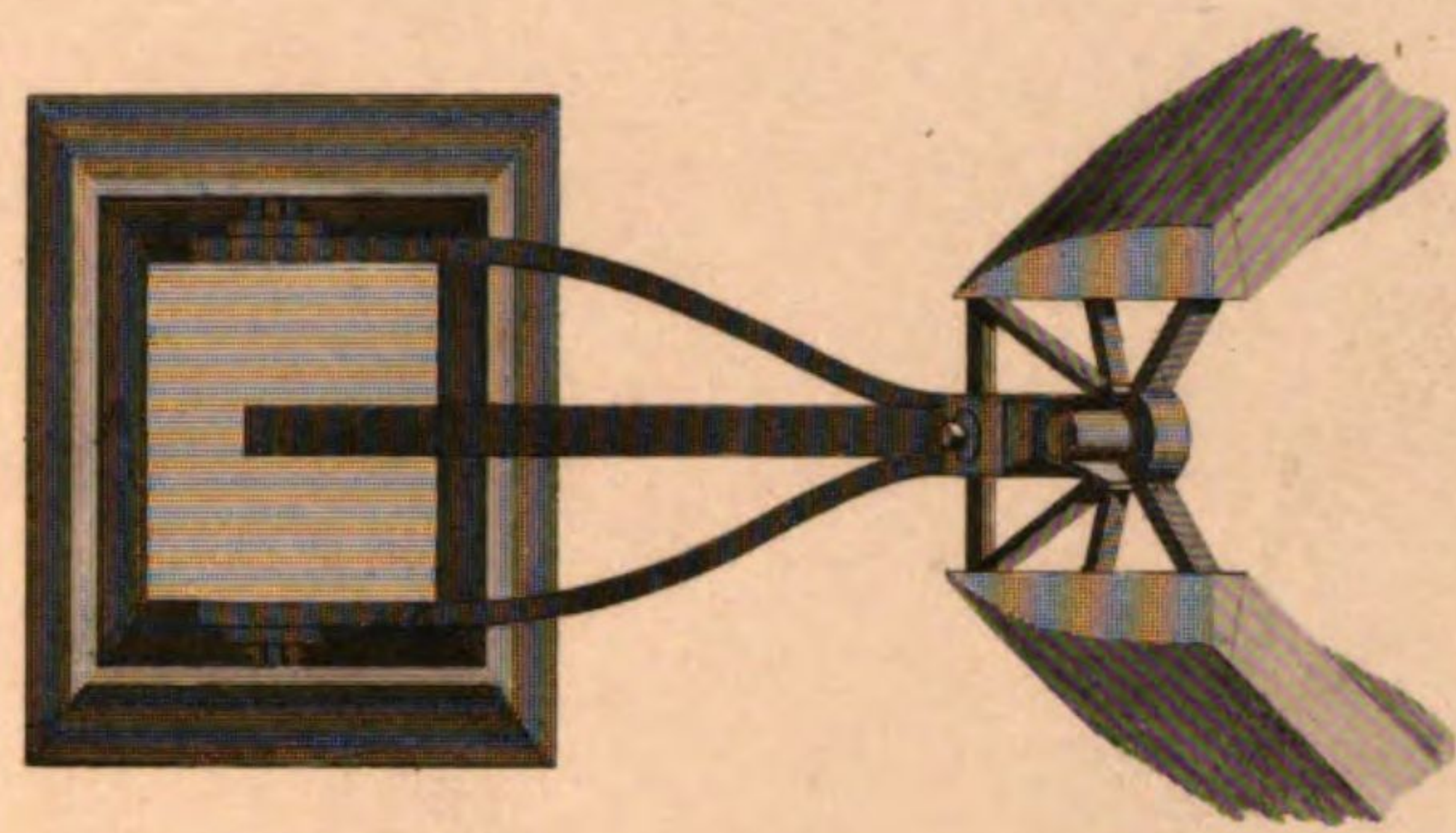
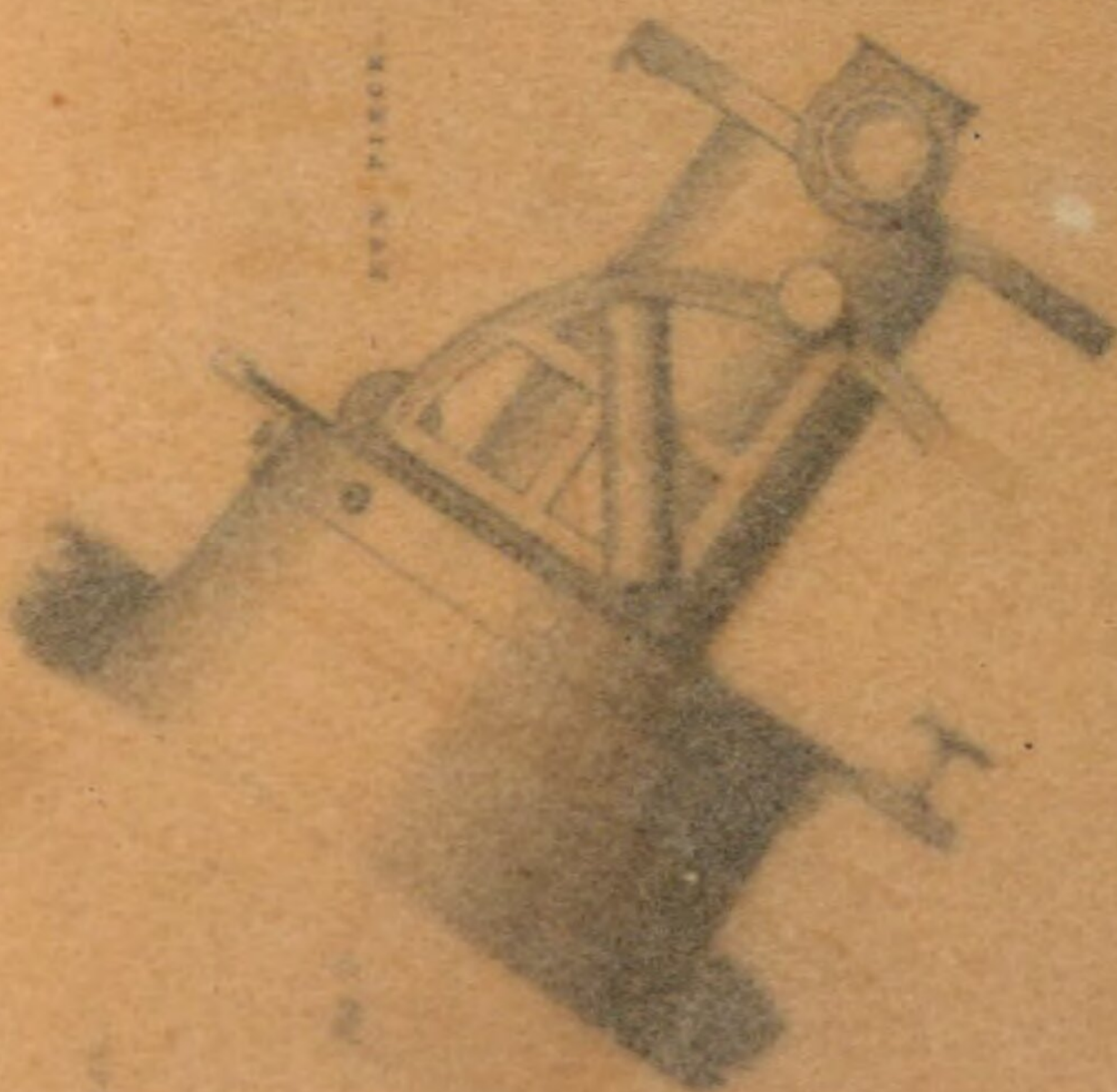
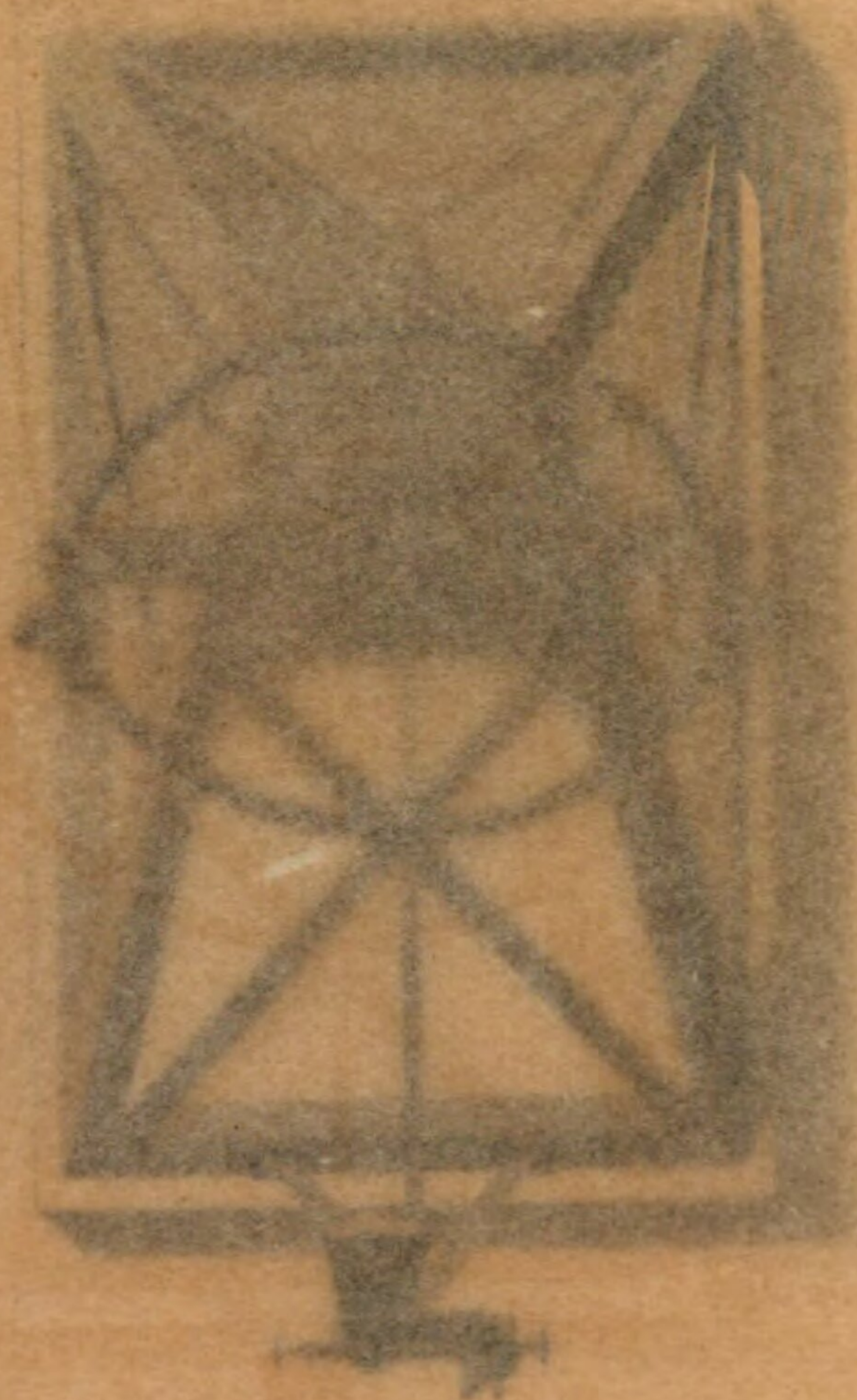
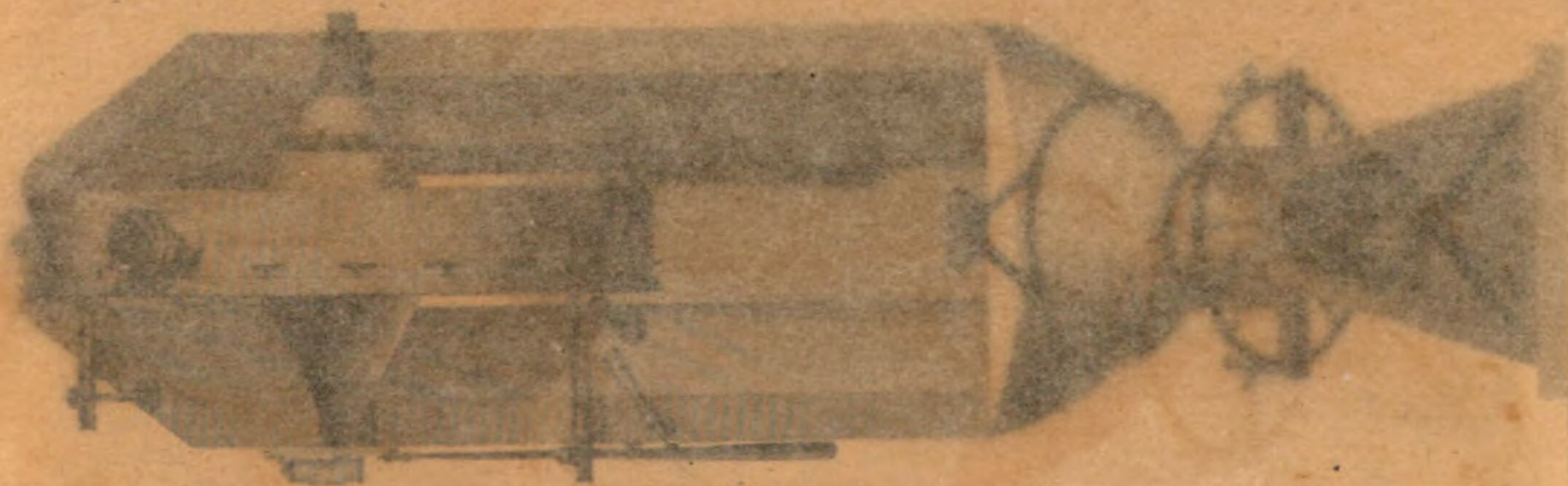


Fig. 1.

FIVE FEET EQUATORIAL.

Fig. 2.





THE GREAT EQUINOXIAL



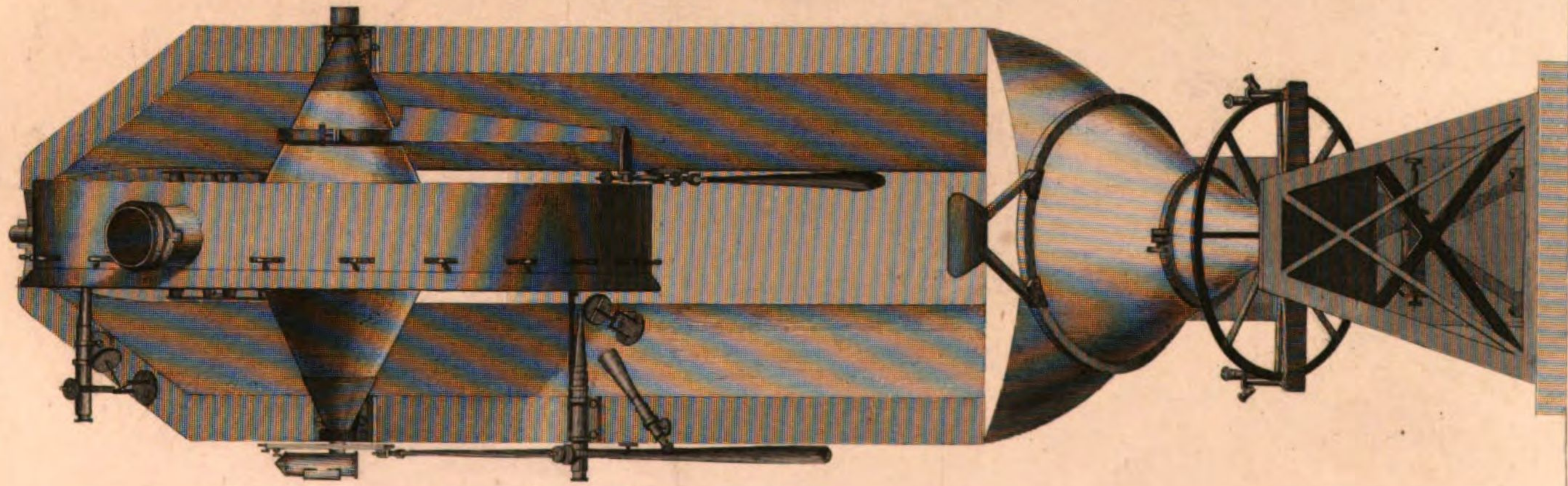


Fig. 1.

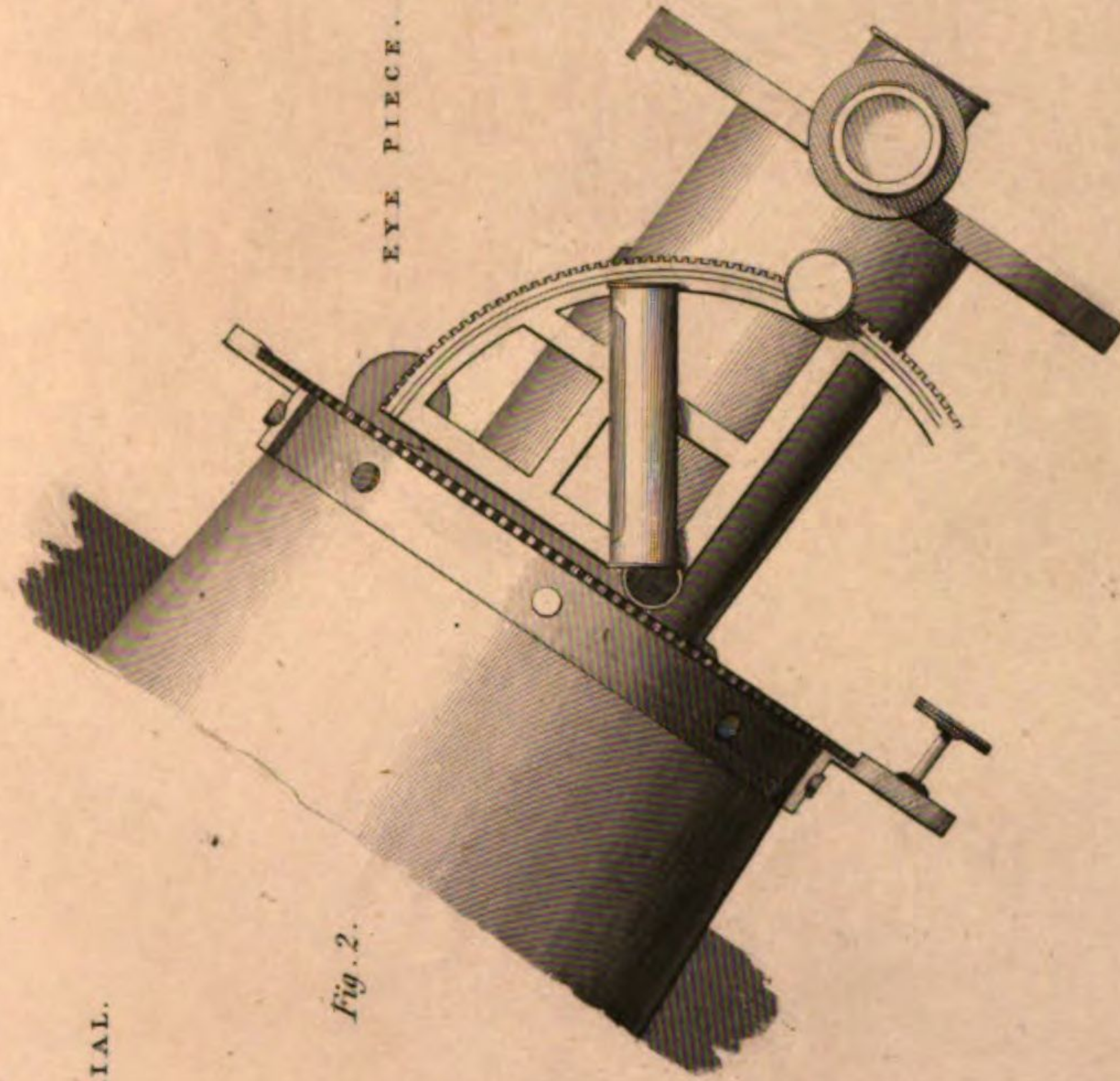
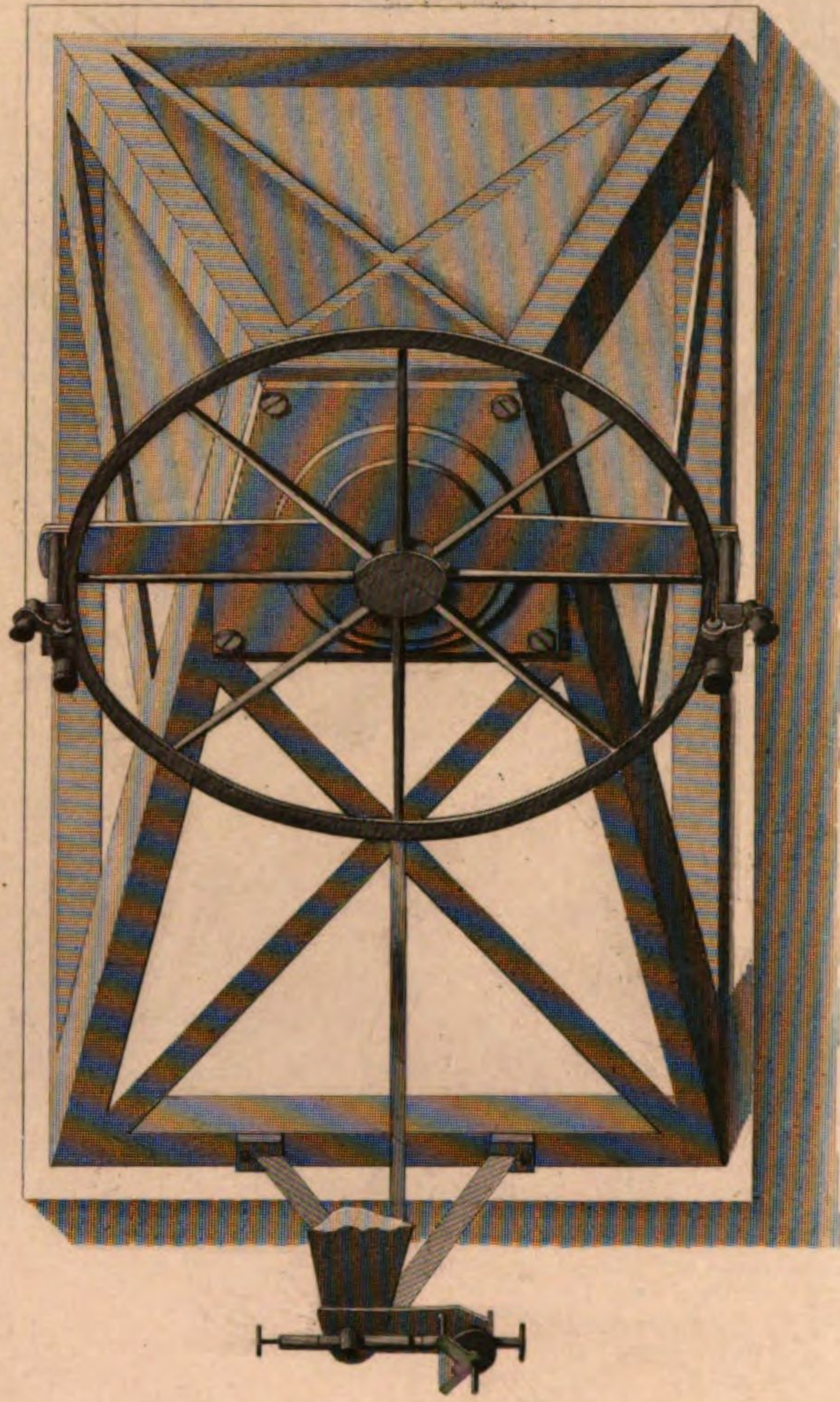


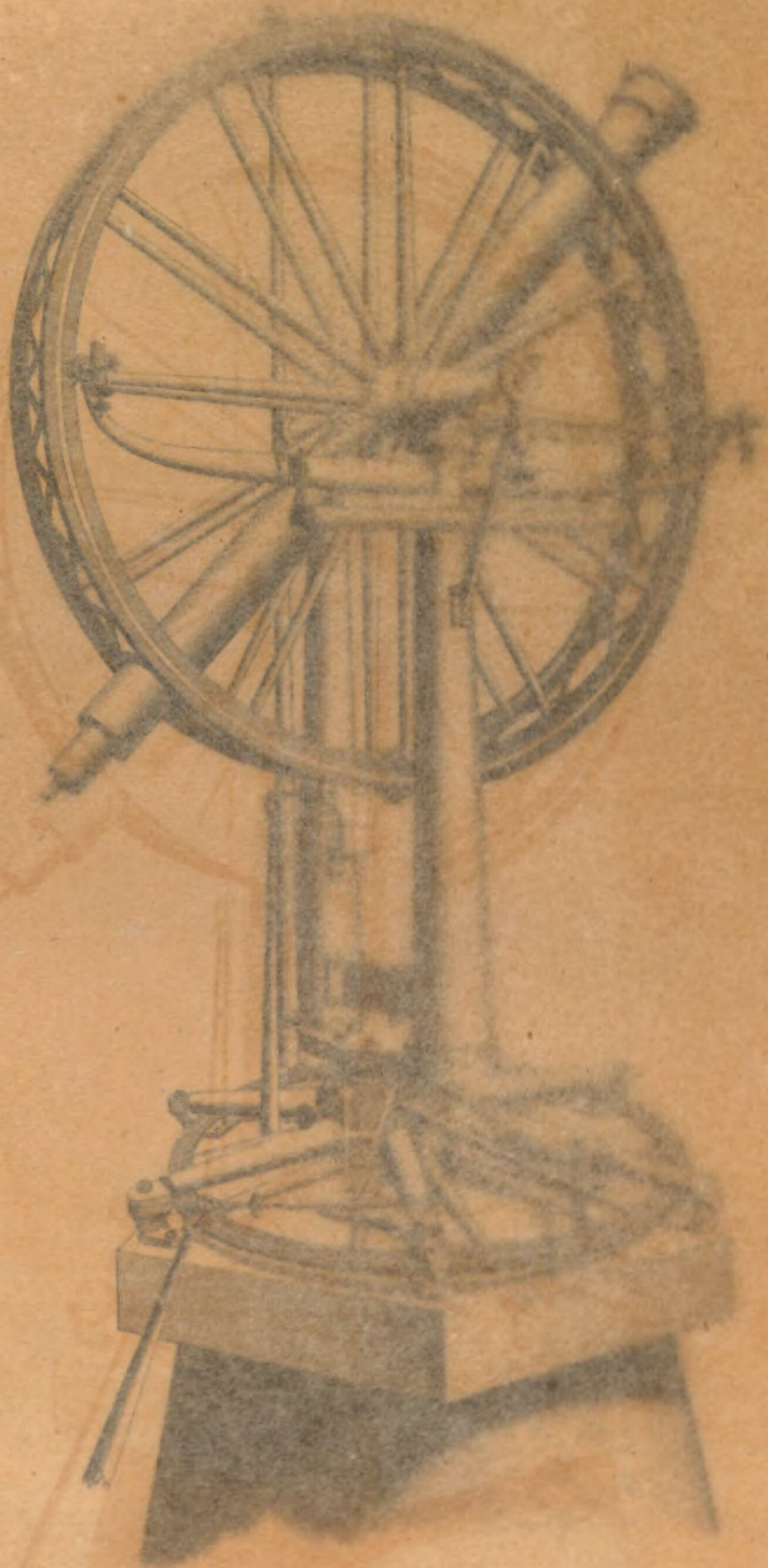
Fig. 2.

EYE PIECE.

Fig. 3.

PLAN OF IRON FRAME AND HOUR CIRCLE.





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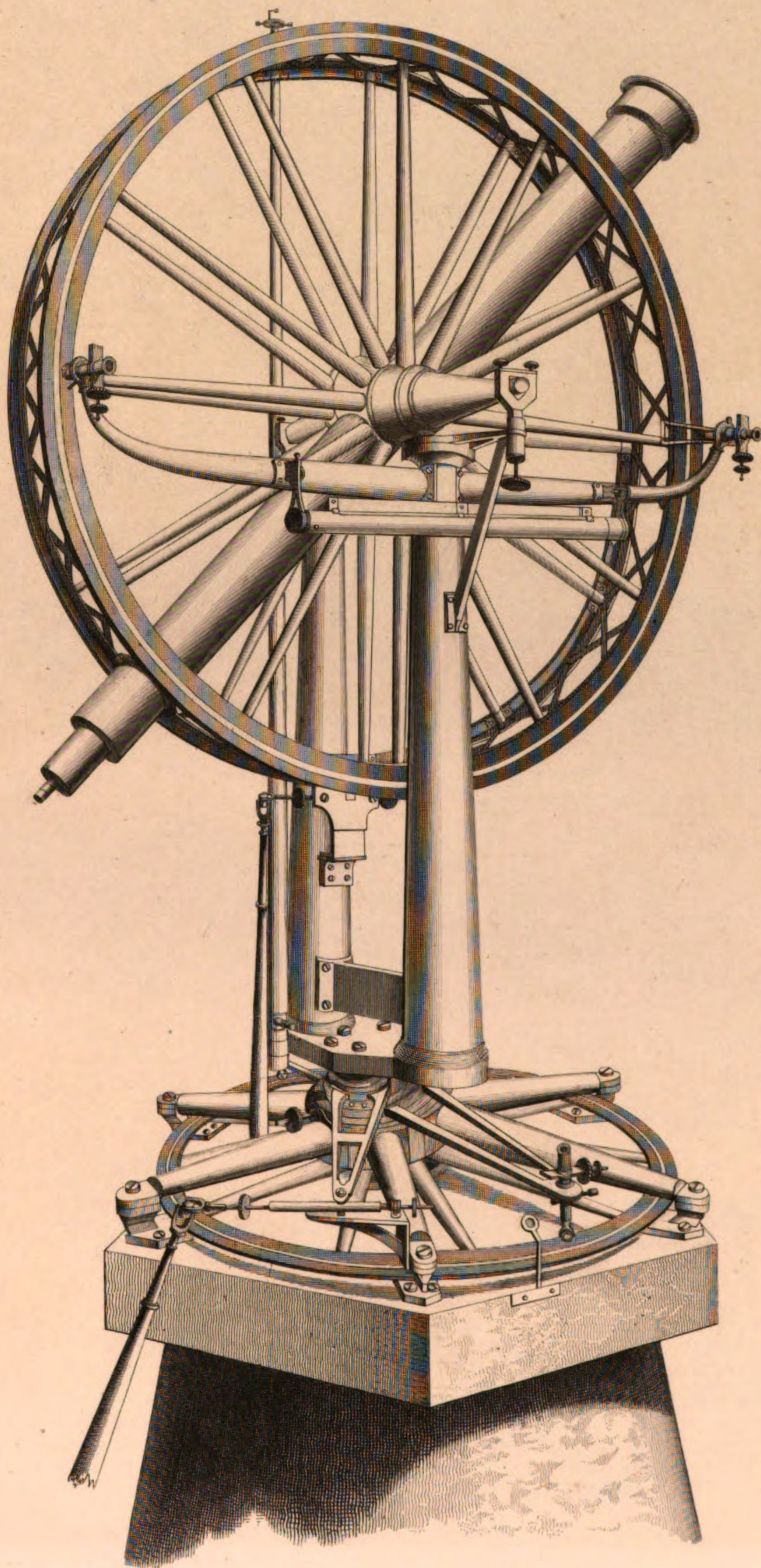
LIBRARY OF THE UNIVERSITY OF CHICAGO



ASTRONOMY.

PLATE C.

AZIMUTH AND ALTITUDE CIRCLE.



Engd by G. Atkman, Edin.

ATTRACTION.

Fig. 1.

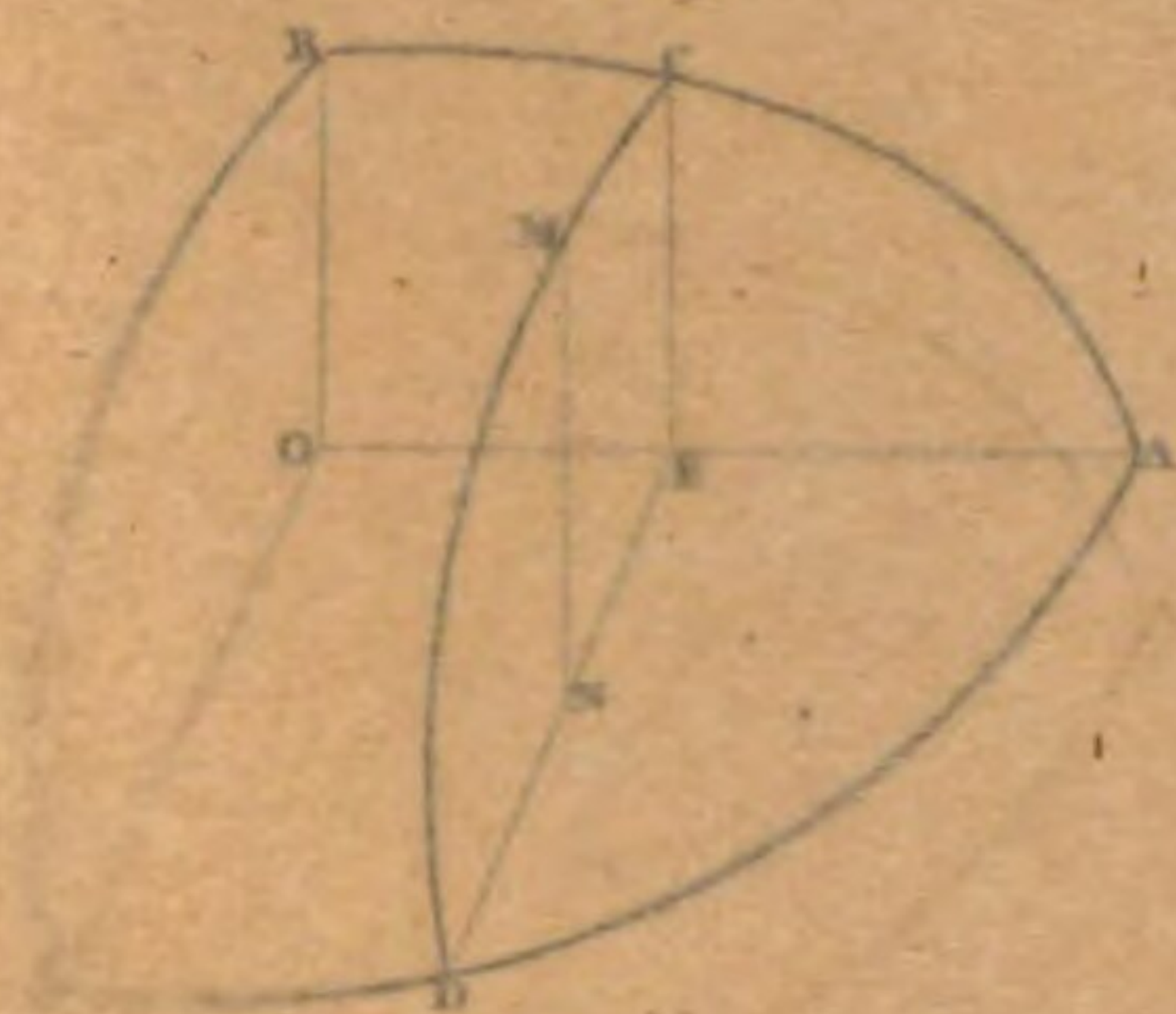


Fig. 2.



Fig. 3.

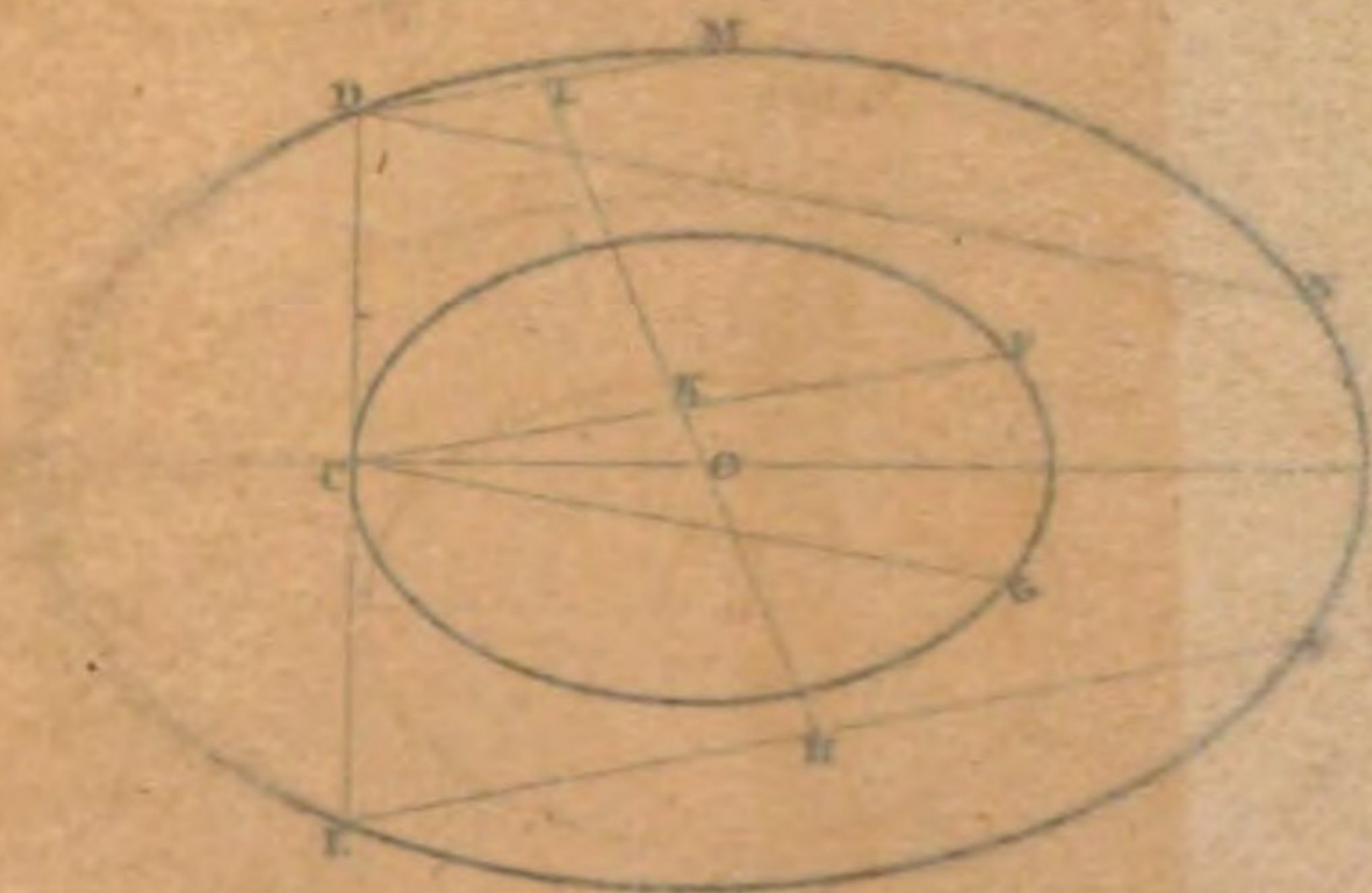


Fig. 4.



Fig. 5.

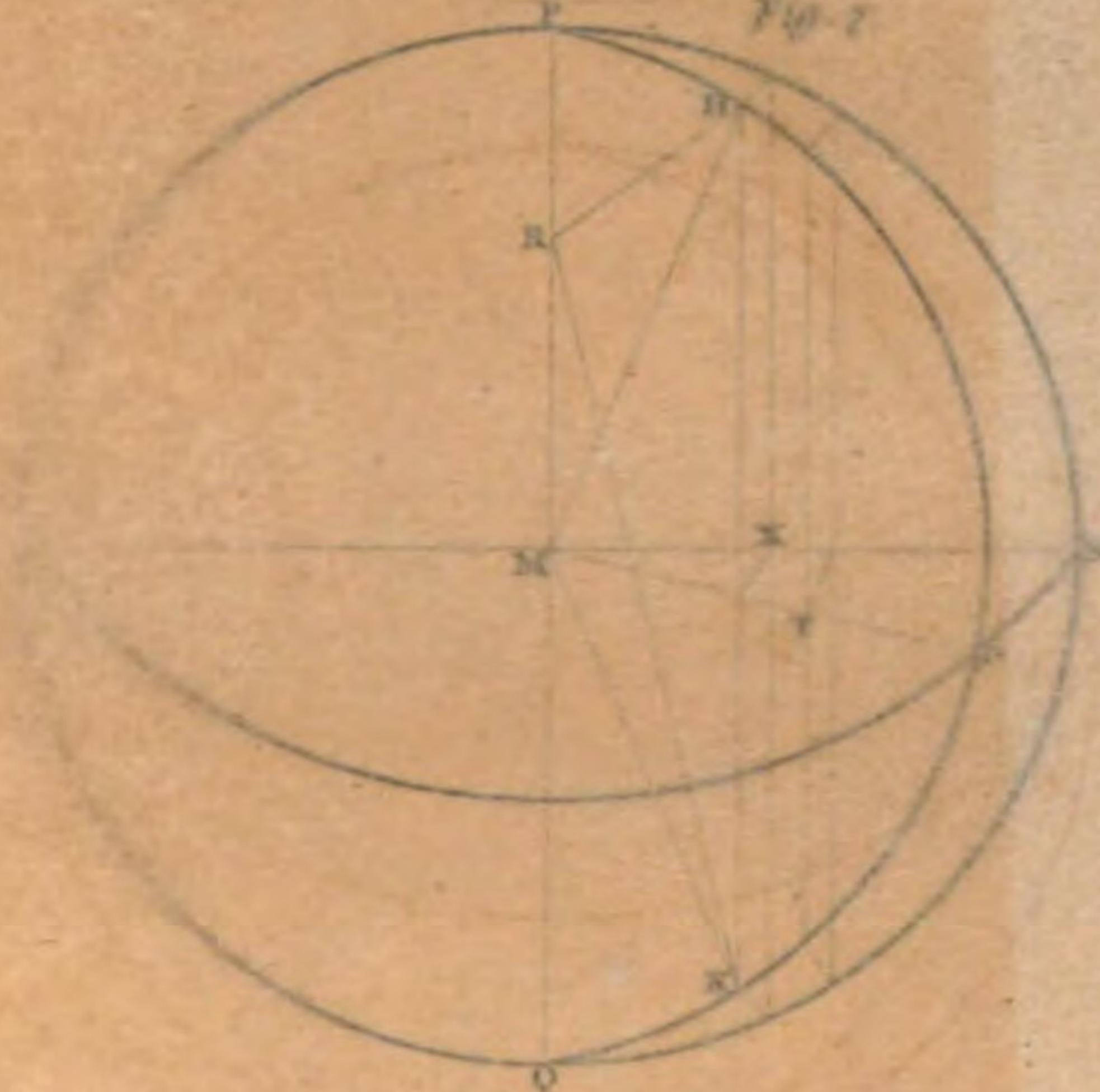


Fig. 6.



Fig. 7.

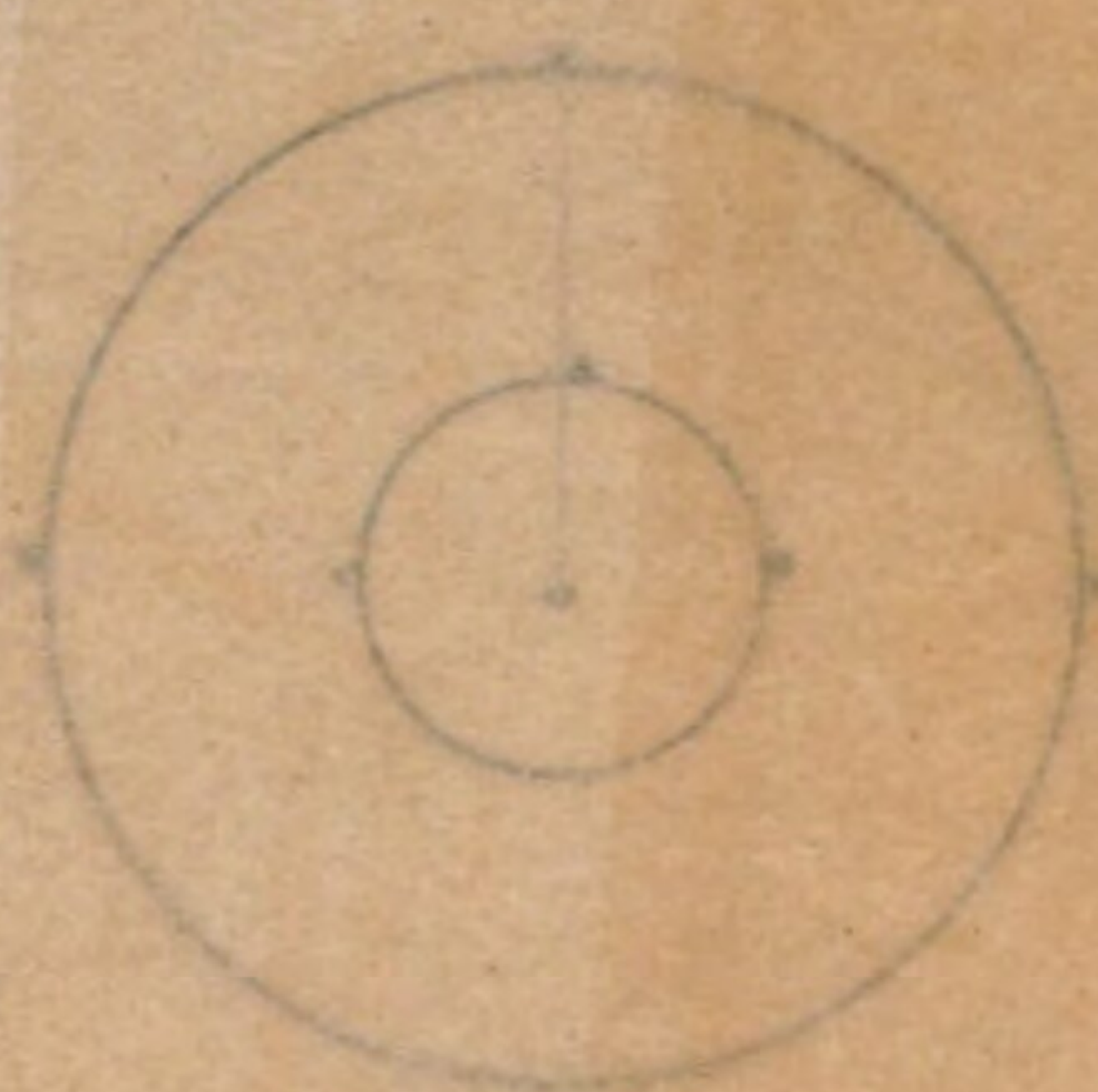


Fig. 8.

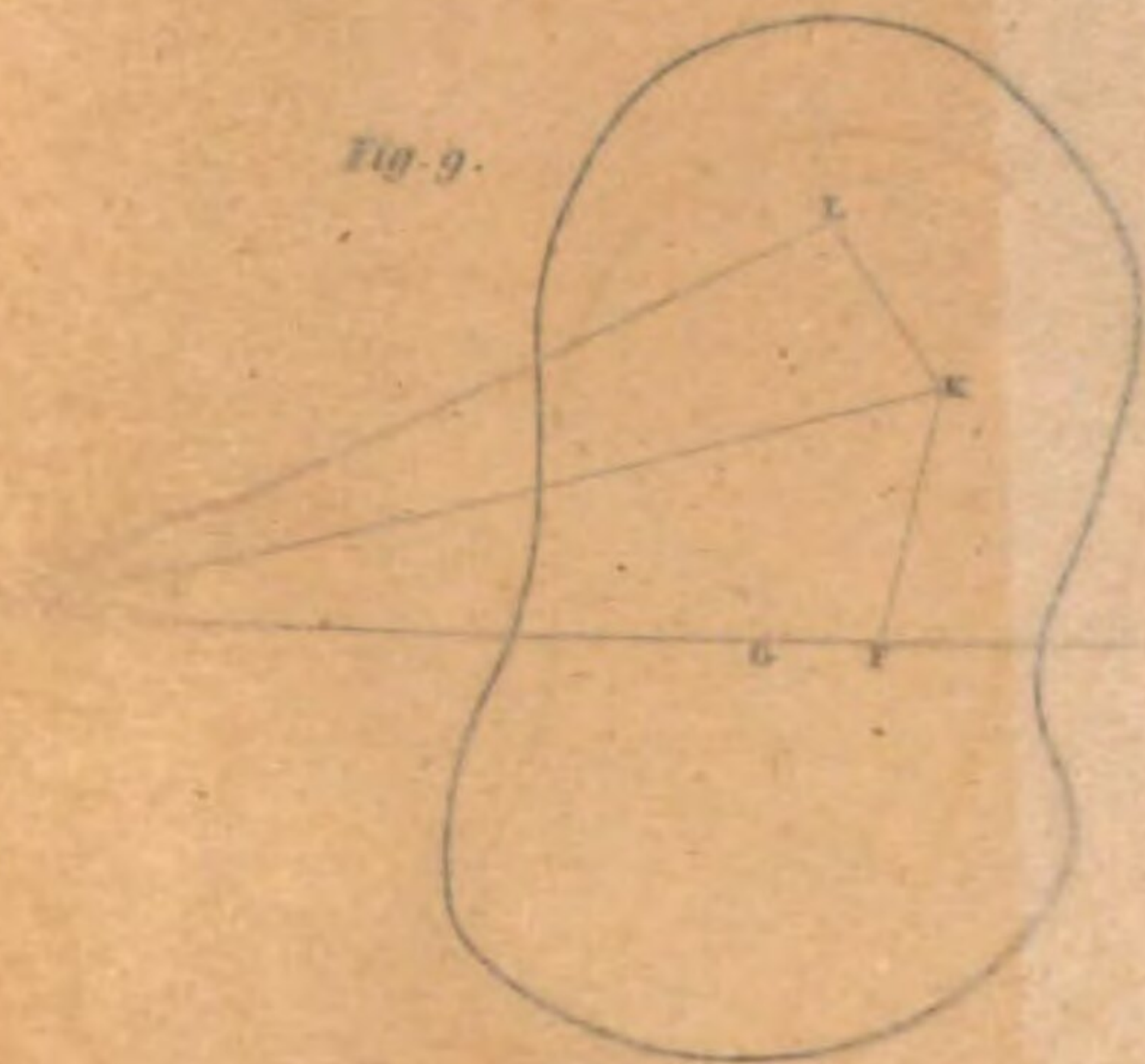


Fig. 9.



1871



Fig. 1.

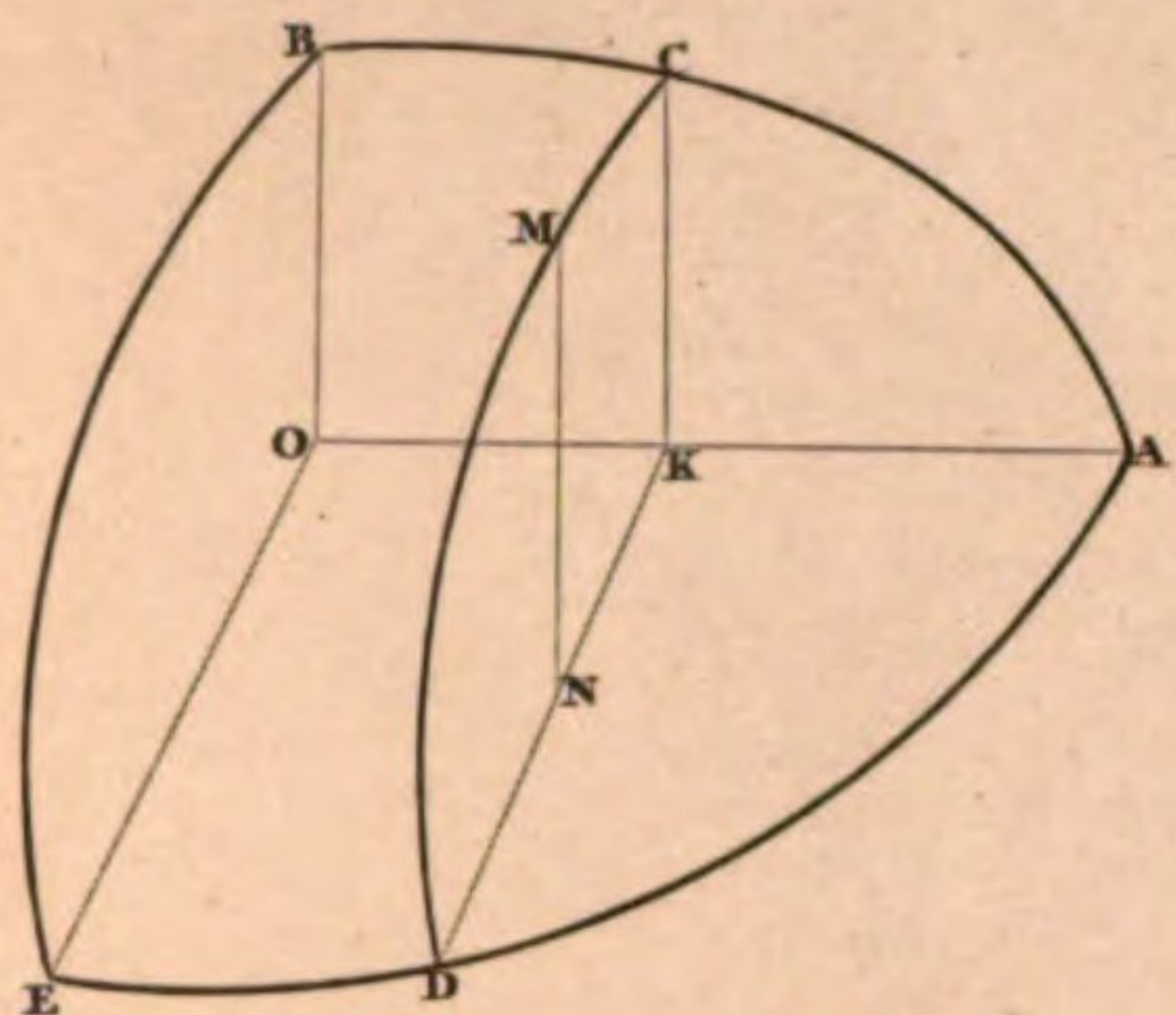


Fig. 2.

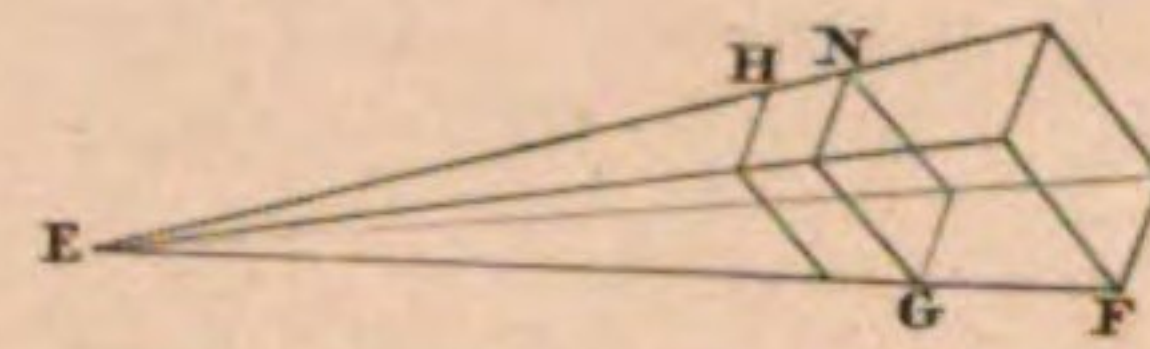
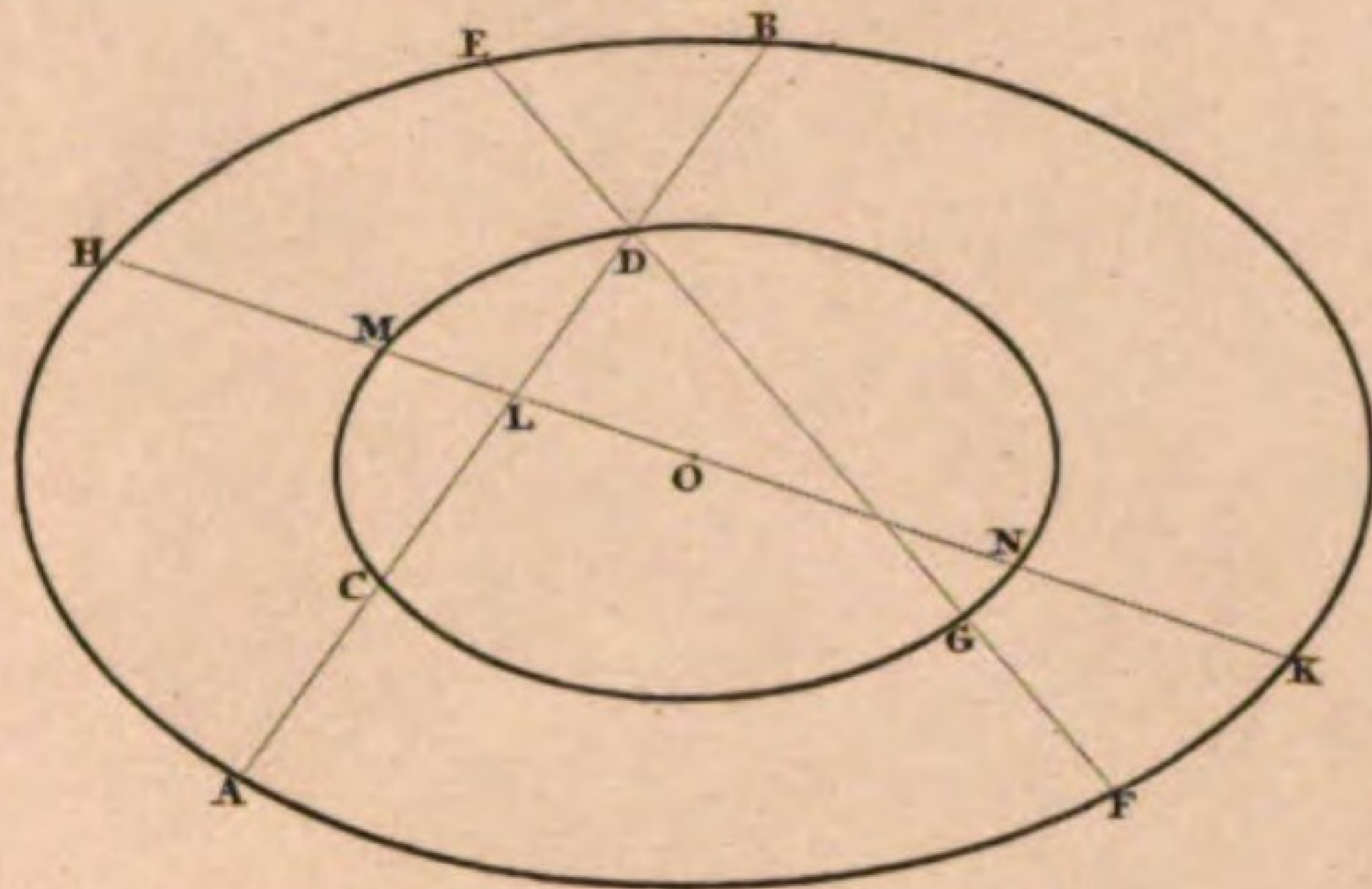


Fig. 4.

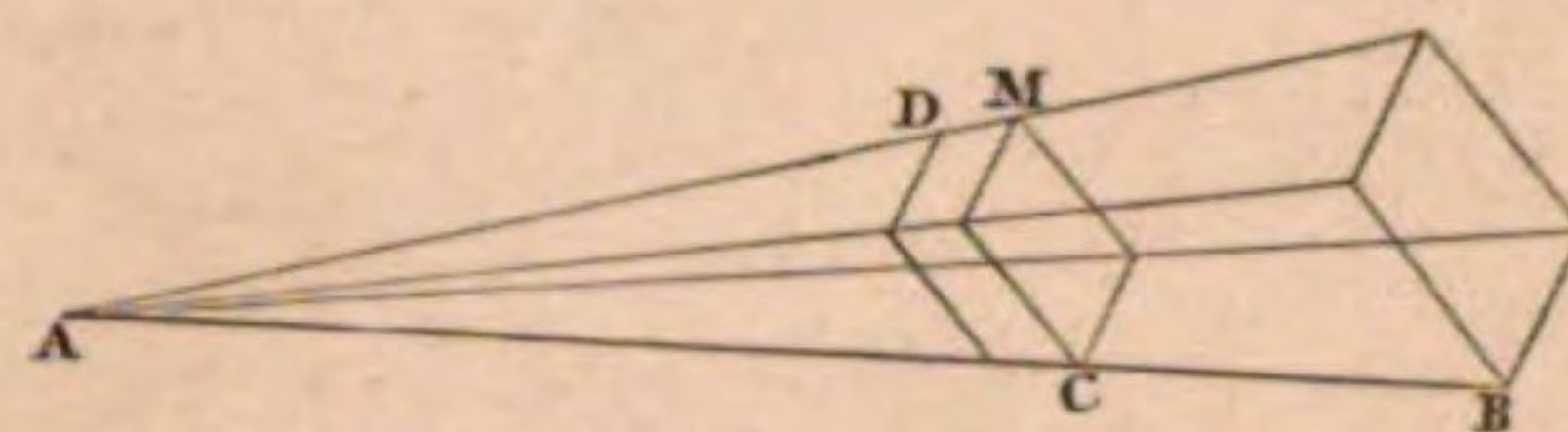


Fig. 5.

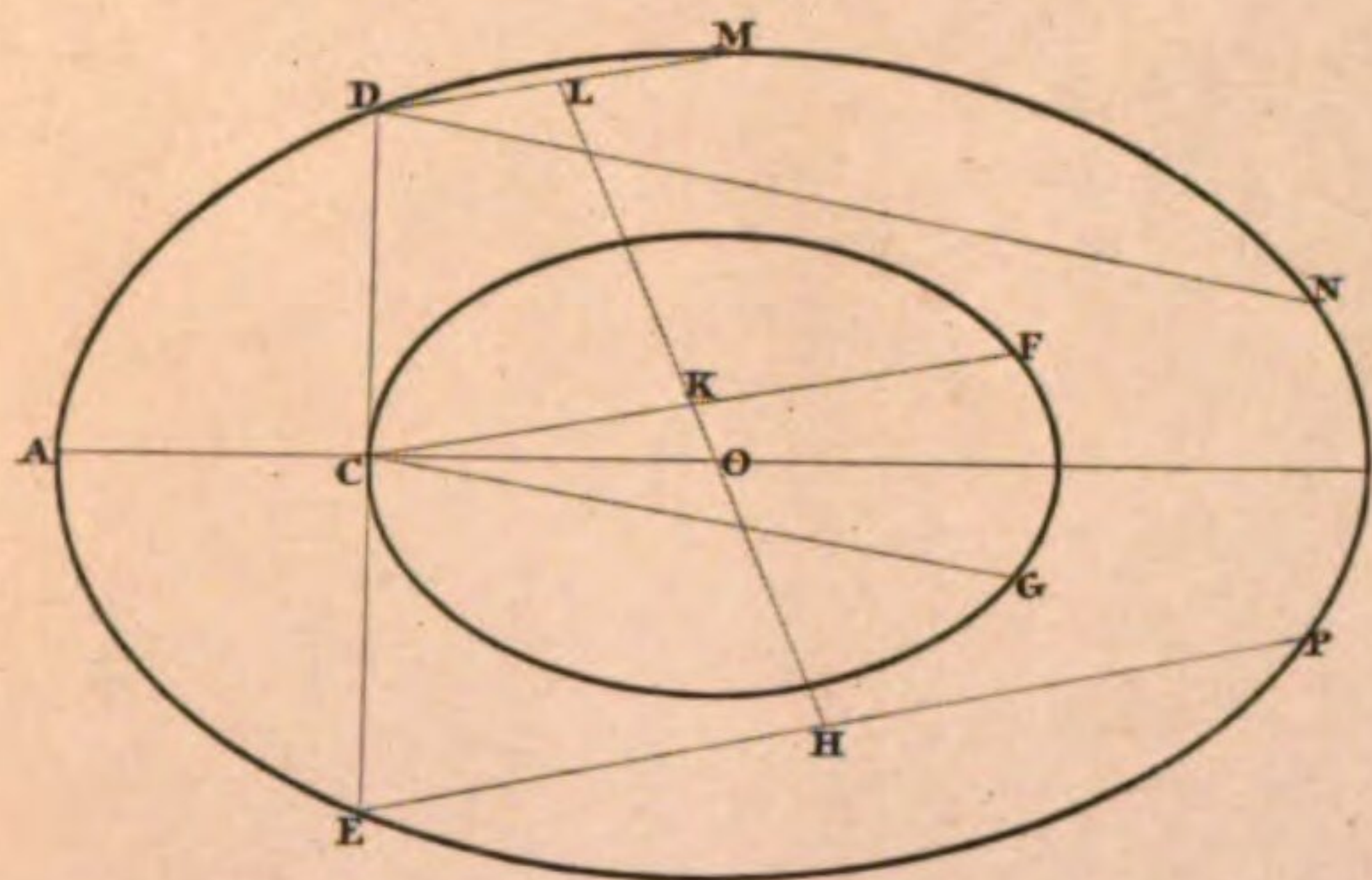


Fig. 6.

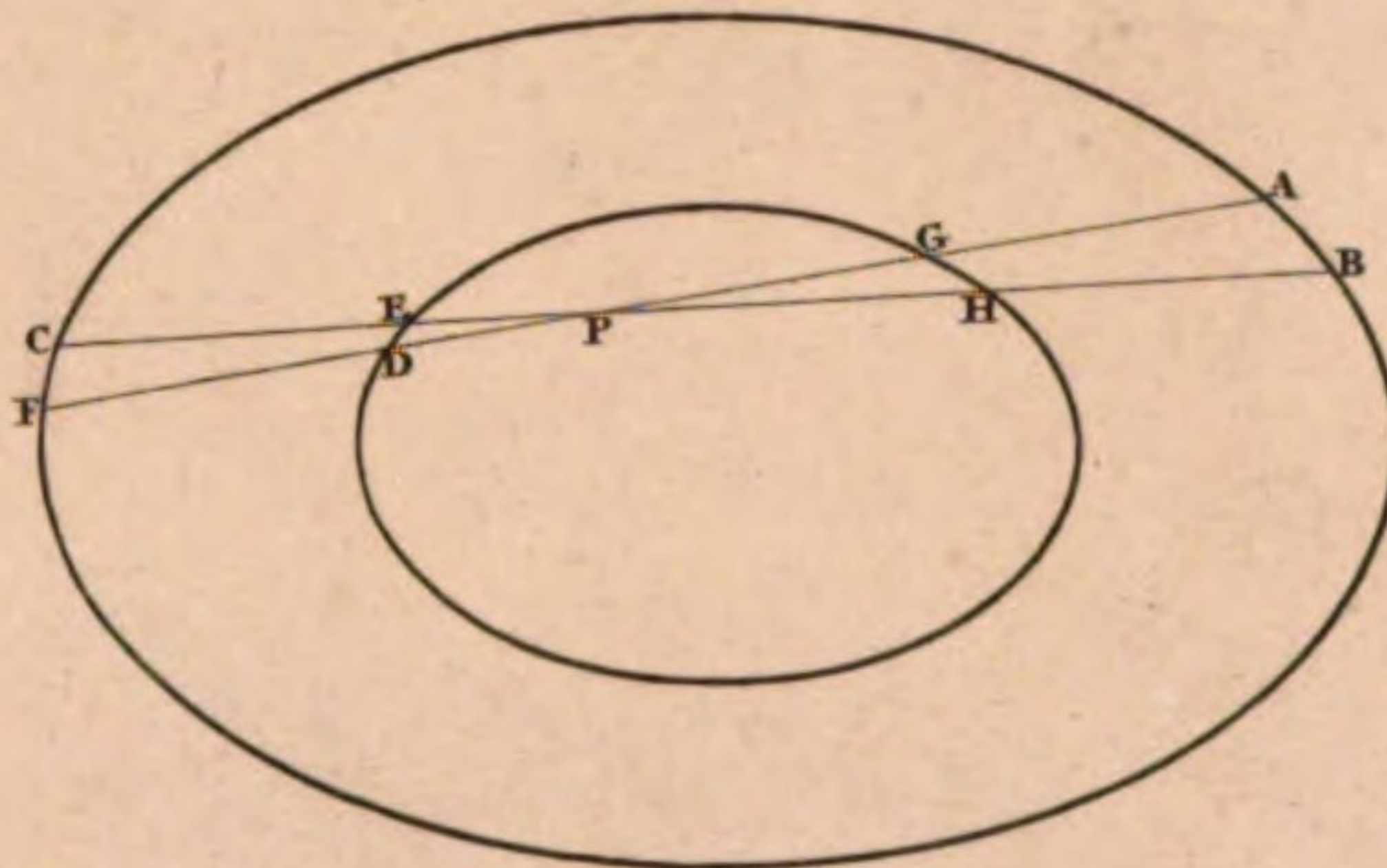


Fig. 7.

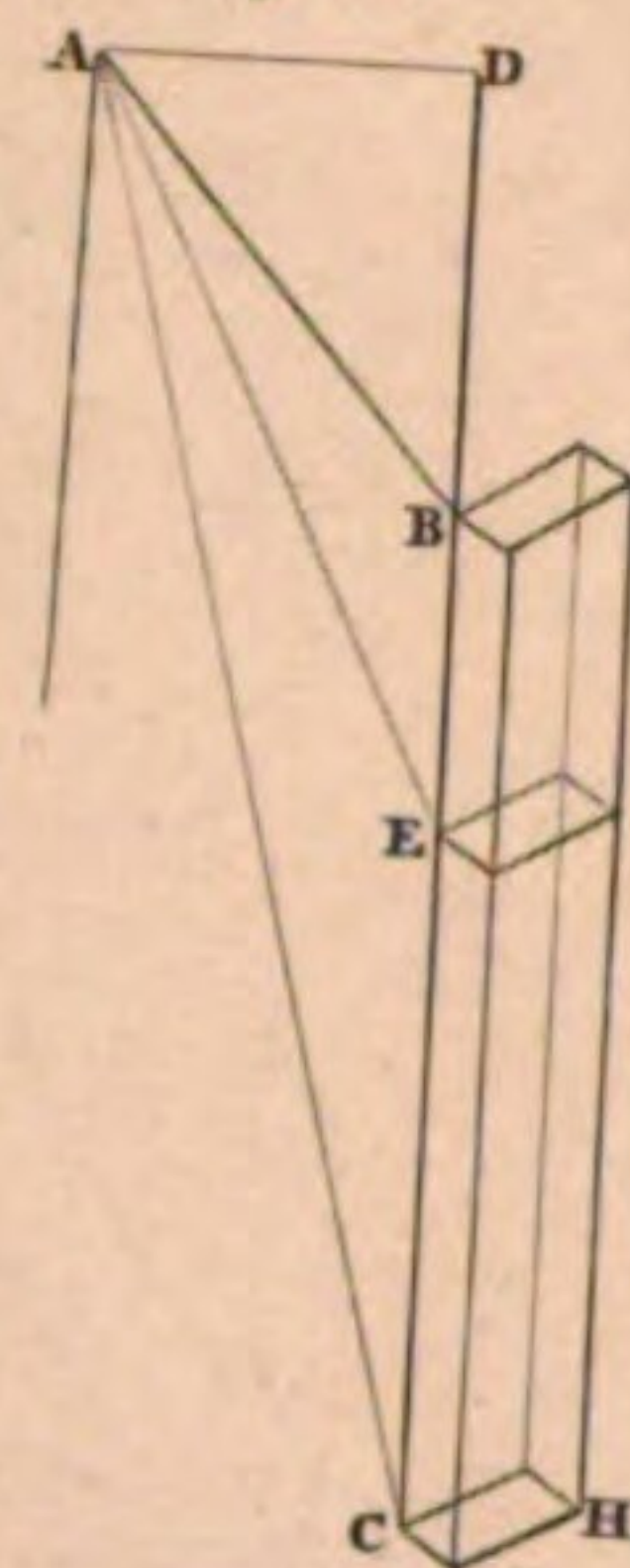


Fig. 8.

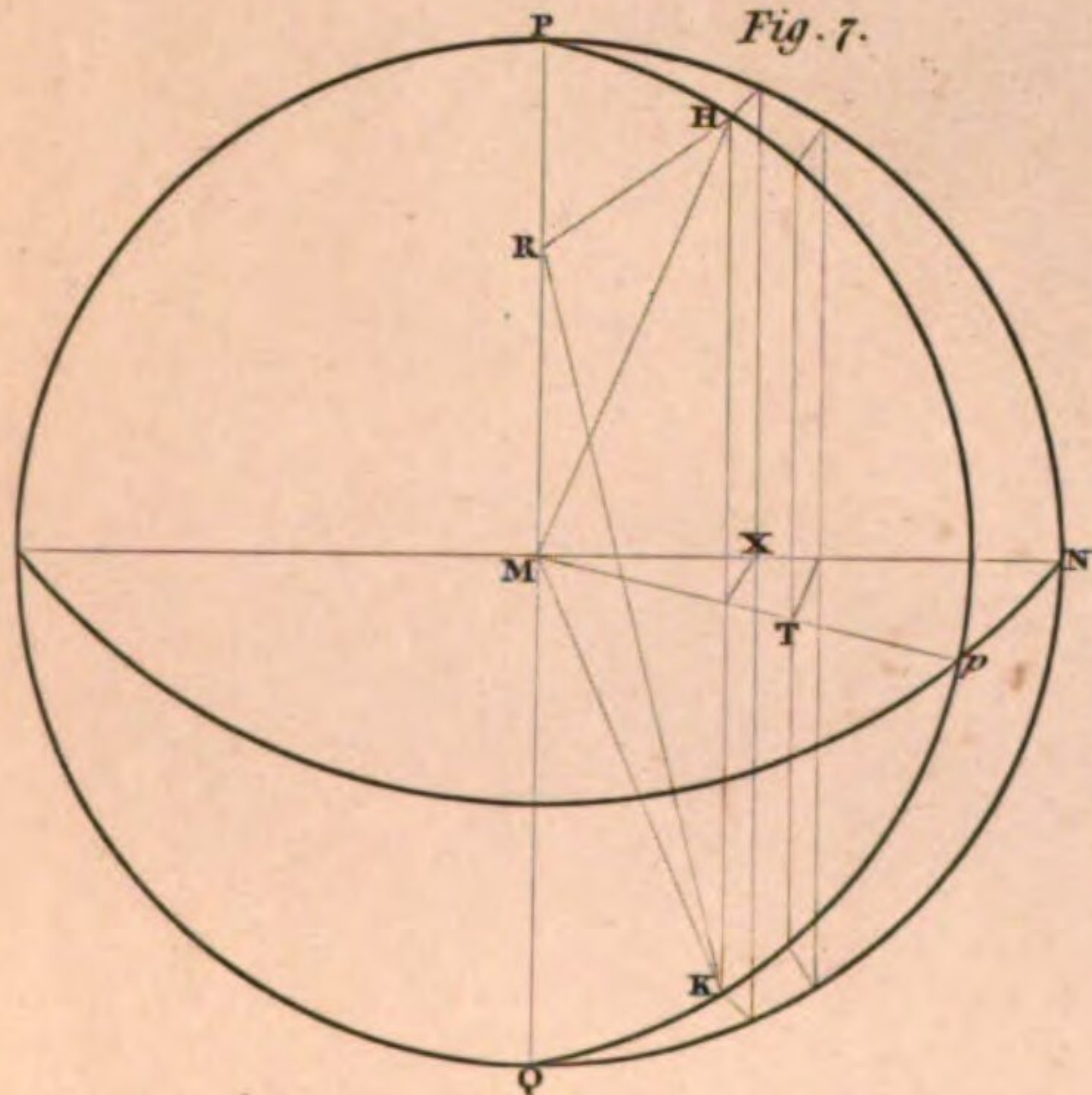


Fig. 9.

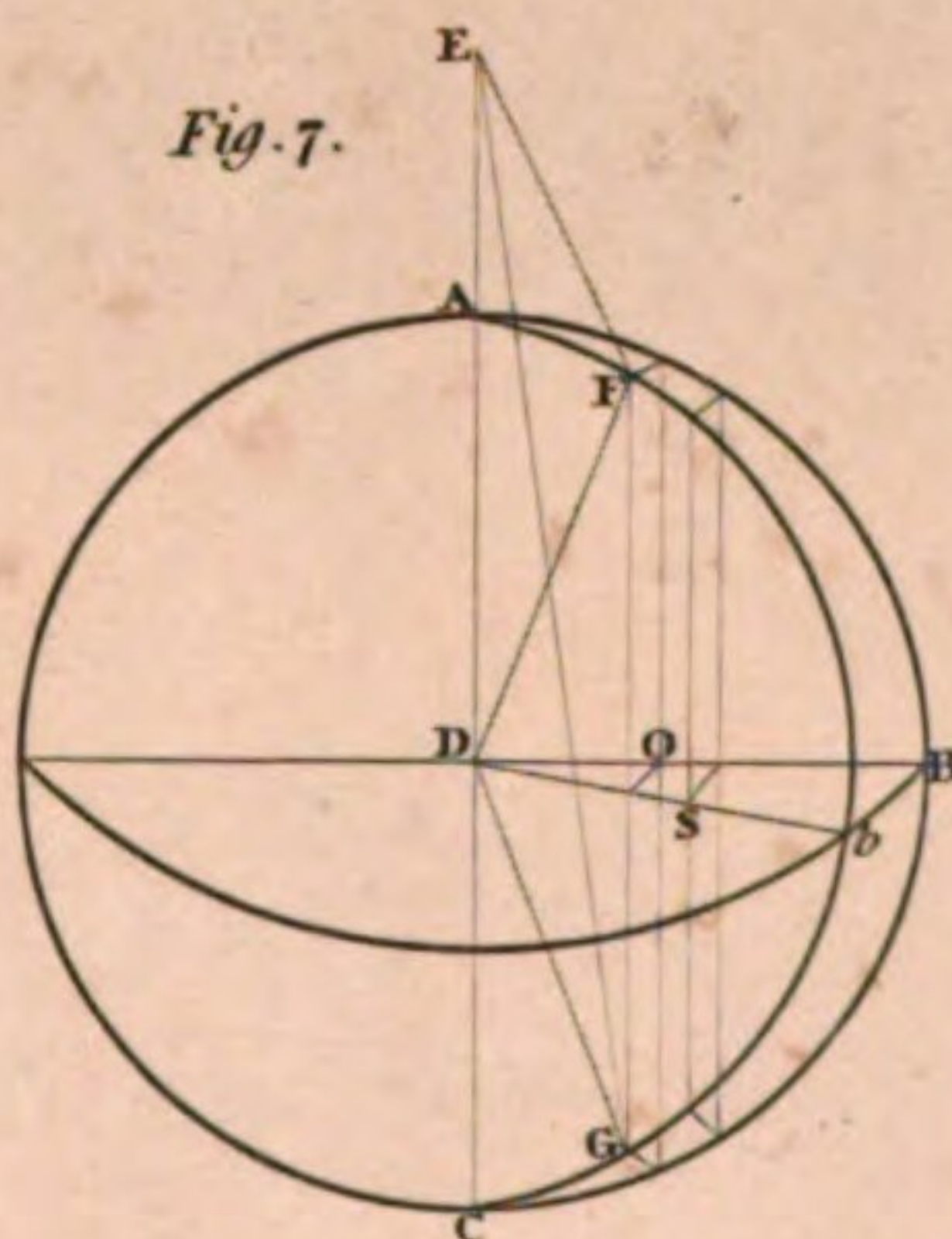


Fig. 10.

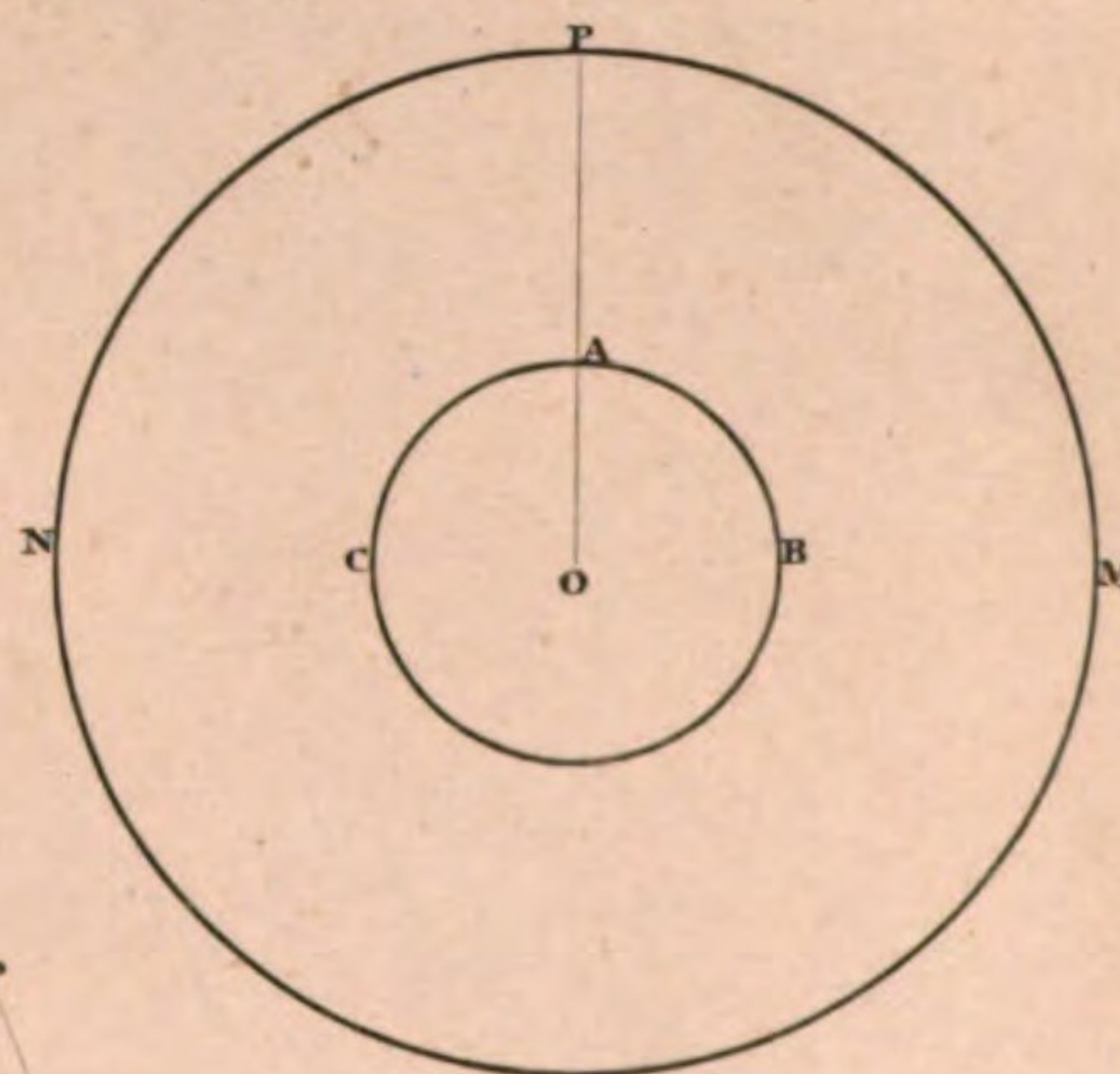


Fig. 11.

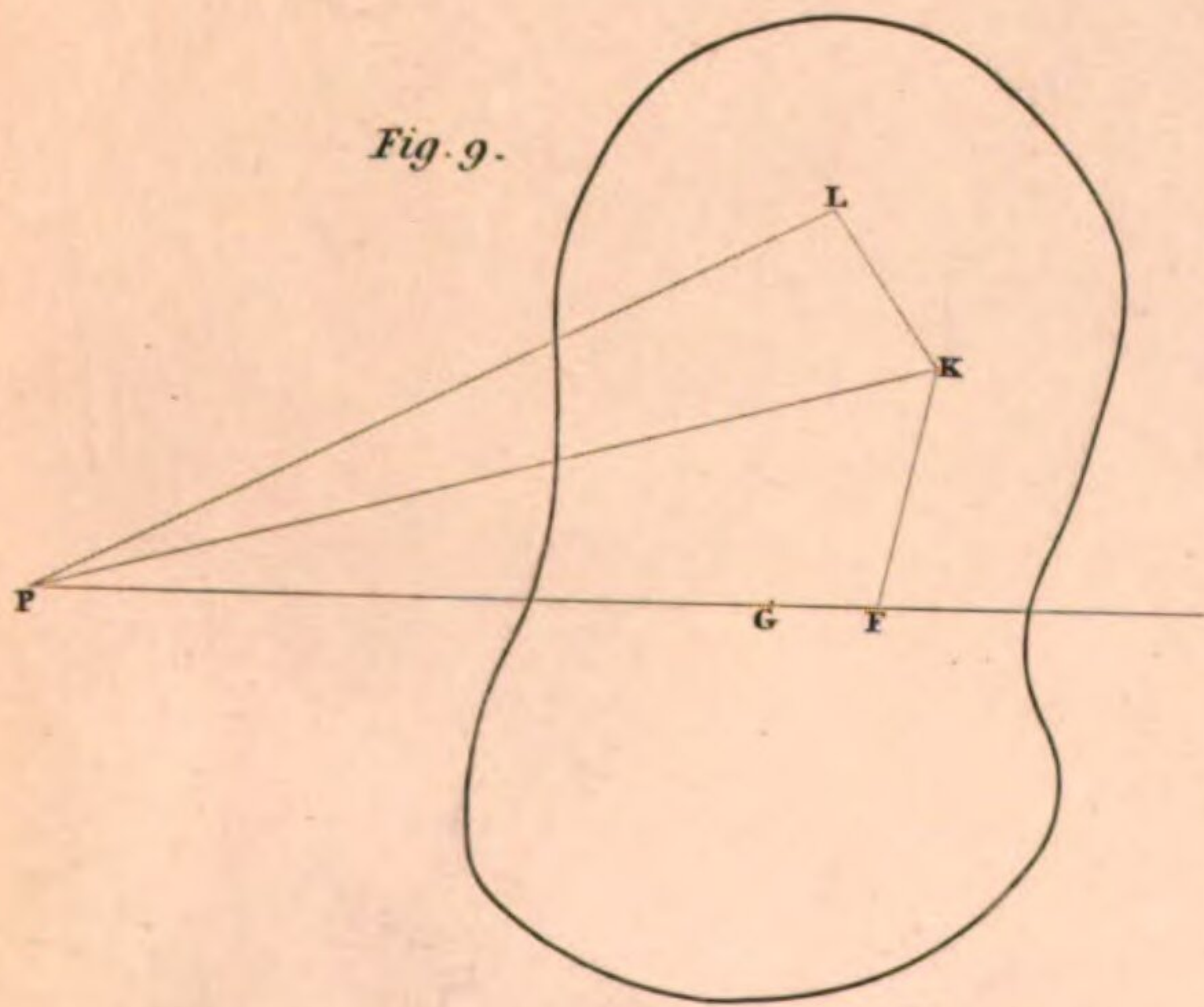
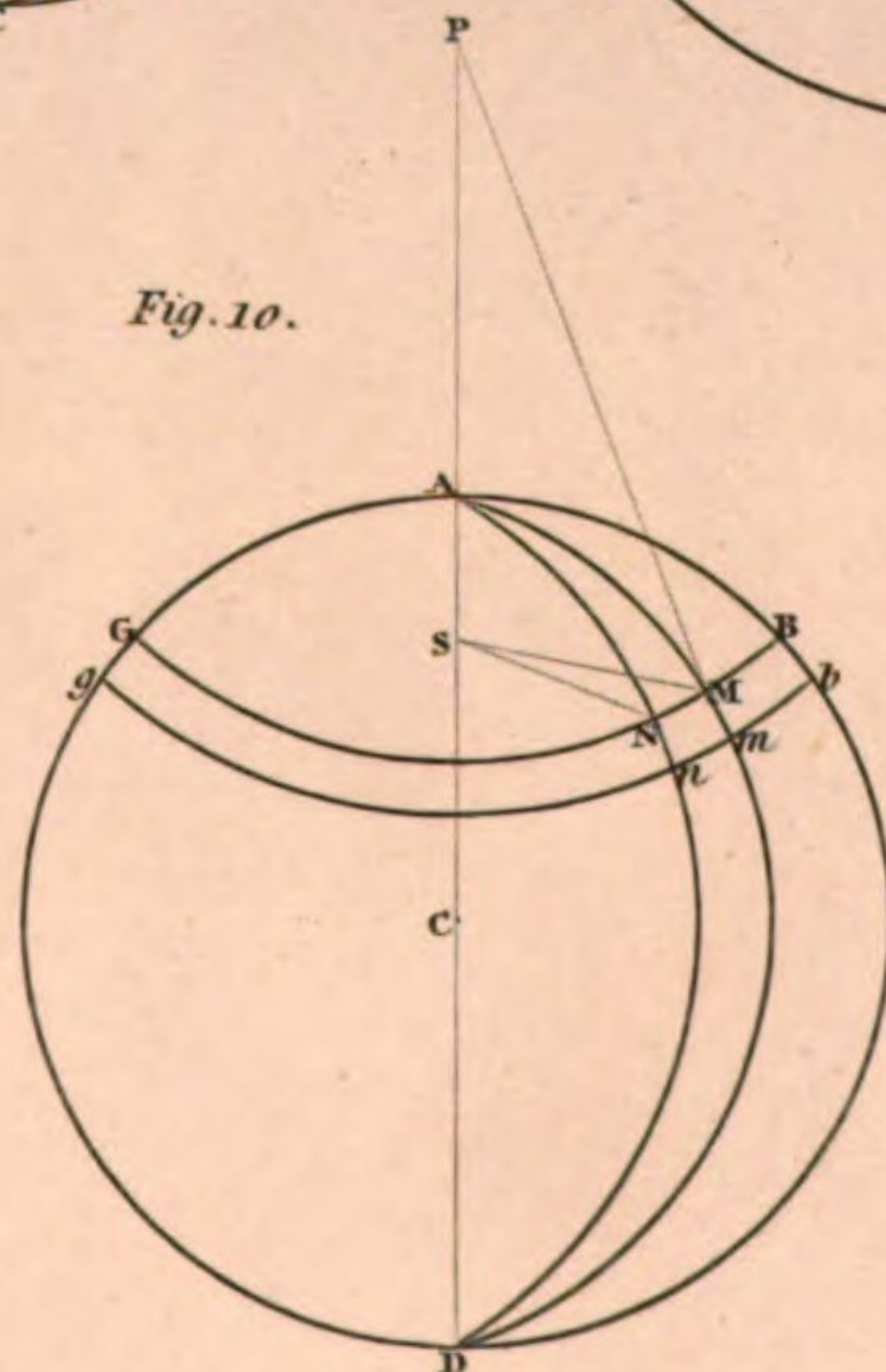


Fig. 12.



The Encyclopaedia Britannica, or Dictionary of Arts, Sciences, and General Literature

Bd.: 4[,1]

Edinburgh (1842)

4 Enc. 7 c-4,1

urn:nbn:de:bvb:12-bsb10484897-9